

# BIOENGINEERING Lakeshores

Shawn Tracy

Landscape Restoration Ecologist

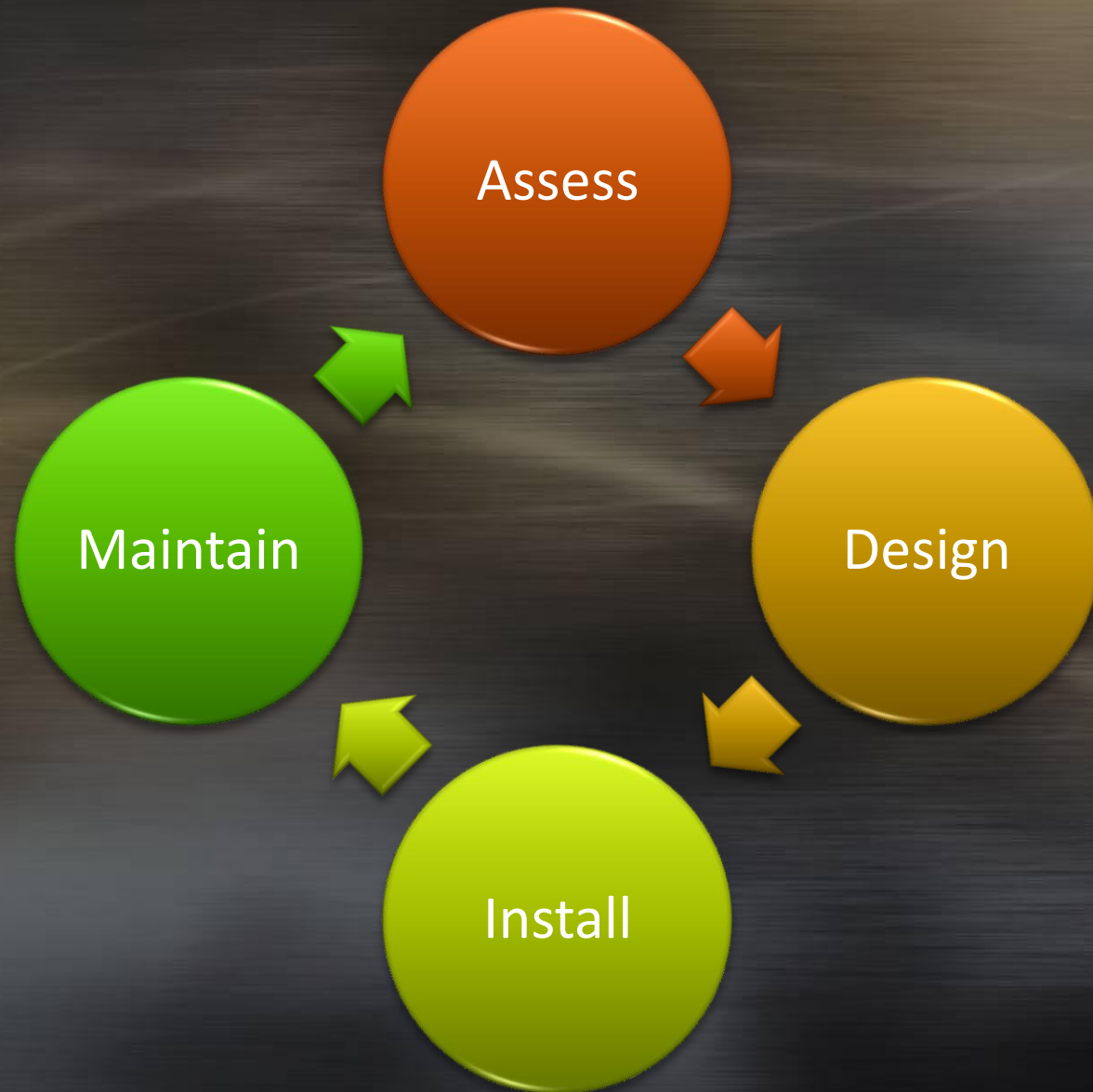
Metro Conservation Districts

# BIOENGINEERING

- Site A
- Site D
- Project
- Project



# A Wise Bioengineering Approach



# ASSESSMENT

- Desktop
- Field



# ASSESSMENT

- Desktop
  - Historical elevation data
  - Published OHWL
  - Bathymetry
  - Fetch
  - Wave energy (height and frequency)
  - Boating

# ASSESSMENT

- Desktop
  - Soils
  - Contours (elevation)
  - Aerial photography
  - Emergent community
  - Herbivore presence
  - Habitat needs

# ASSESSMENT

- Desktop
  - Historical plant community



**BASE MAP**



LAKE FINDER

Enter Keywords

[Site Map](#) | [Contact the DNR](#) | [What's New?](#) | [Newsroom](#) | [Events & Seasons](#)> [MN DNR Home](#) > [Lake Finder](#) >

## Lake water level report

Lake name: Cedar

County: Scott

### Water Level Data

Period of record: 04/28/1989 to 11/26/2007

# of readings: 274

Highest recorded: 944.48 ft (06/28/1998)

Lowest recorded: 942.06 ft (10/26/1989)

Recorded range: 2.42 ft

Average water level: 943.45 ft

Last reading: 942.69 ft (11/26/2007)

[OHW](#) elevation: 943.4 ft

Datum: 1929 (ft)

Download lake level data as: [dBase](#) [ASCII](#) (If you have trouble try right clicking on the appropriate link and choosing the "Save ... As" option.)

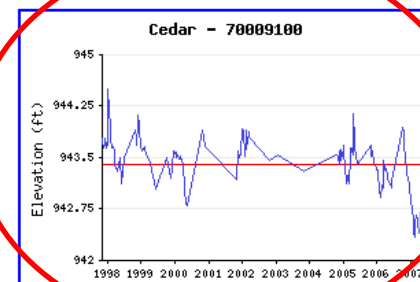
### Benchmarks

Elevation: 945.23 ft

Date Set: 11/17/1986

Datum: 1929 (ft)

Description: Chiseled "x" in right upstream abutment of outlet structure on N end of lake.



Last 10 years of data, click to enlarge.

### Benchmark Location

Township: 113 Range: 22 Section: 7

© 2008 Minnesota Department of Natural Resources. [Copyright Notice](#).Web site policies: [Accessibility](#), [Linking](#), [Privacy](#)

# Lake water level report

Lake name: Cedar

## Water Level Data

Period of record: 04/28/1989 to 11/26/2007

# of readings: 274

Highest recorded: 944.48 ft (06/28/1998) ←

Lowest recorded: 942.06 ft (10/26/1989) ←

Recorded range: 2.42 ft

→ Average water level: 943.45 ft

Last reading: 942.69 ft (11/26/2007) ←

→ OHW elevation: 943.4 ft

Datum: 1929 (ft)

Download lake level data as: [[dBase](#)] [[ASCII](#)] (If you have trouble try right clicking on the appropriate link)

## Benchmarks

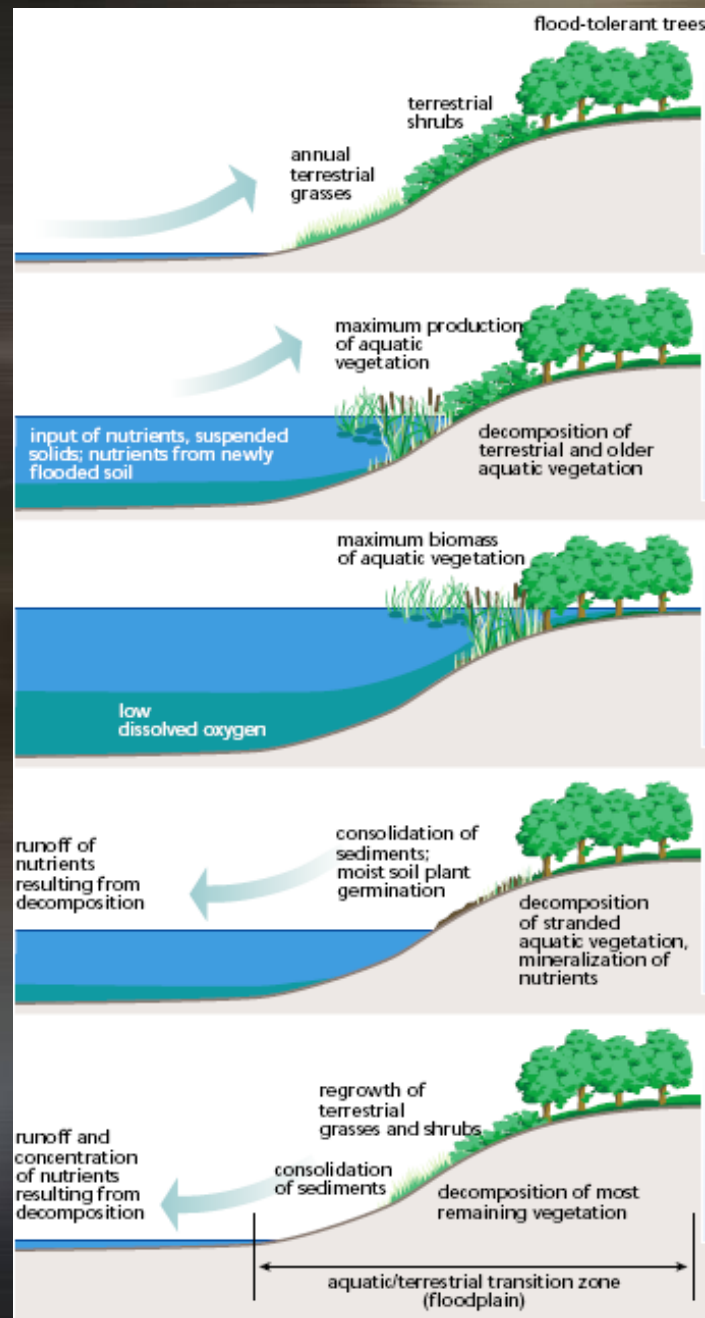
Elevation: 945.23 ft

Date Set: 11/17/1986

Datum: 1929 (ft)

Description: Chiseled "x" in right upstream abutment of outlet structure on N end of lake.



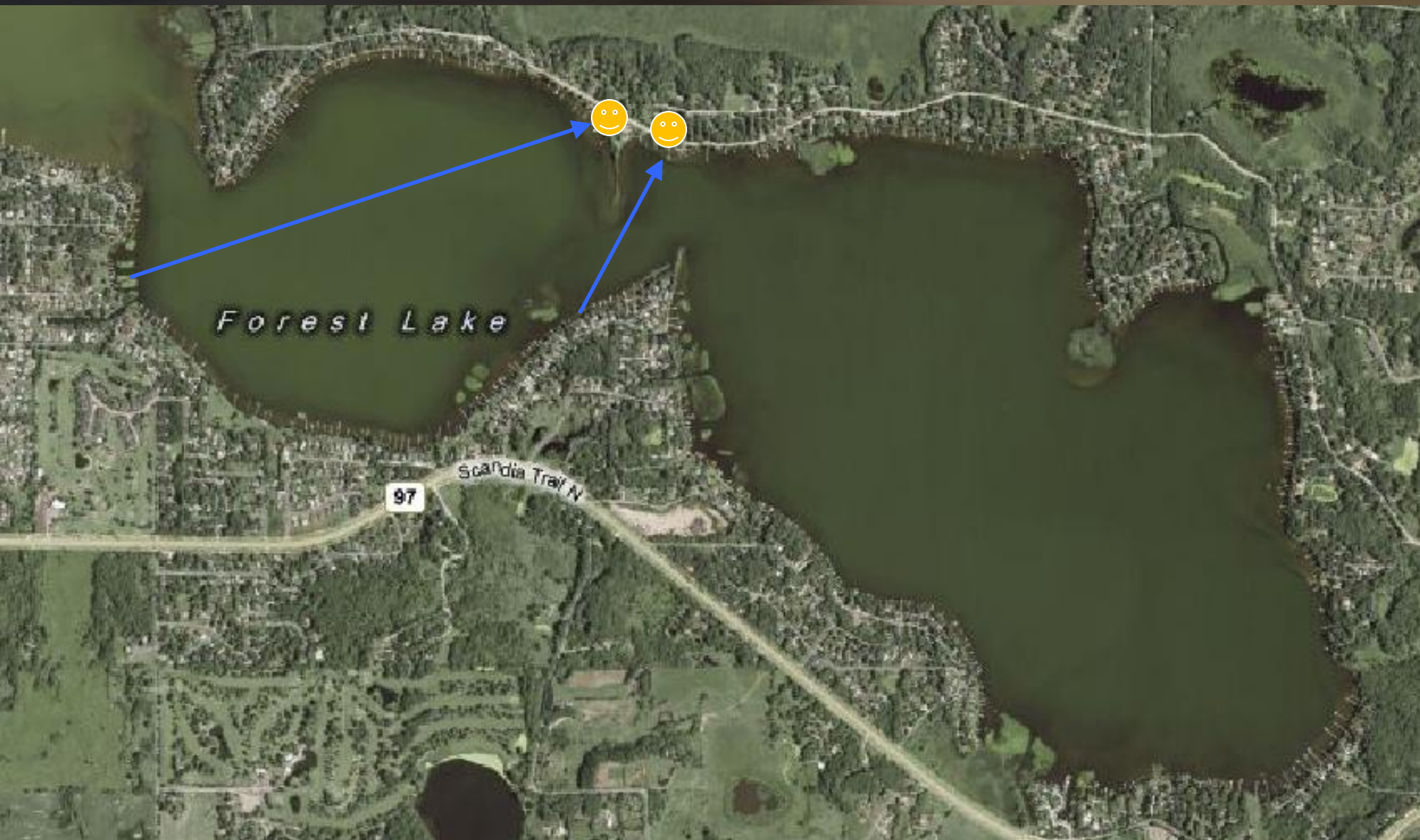




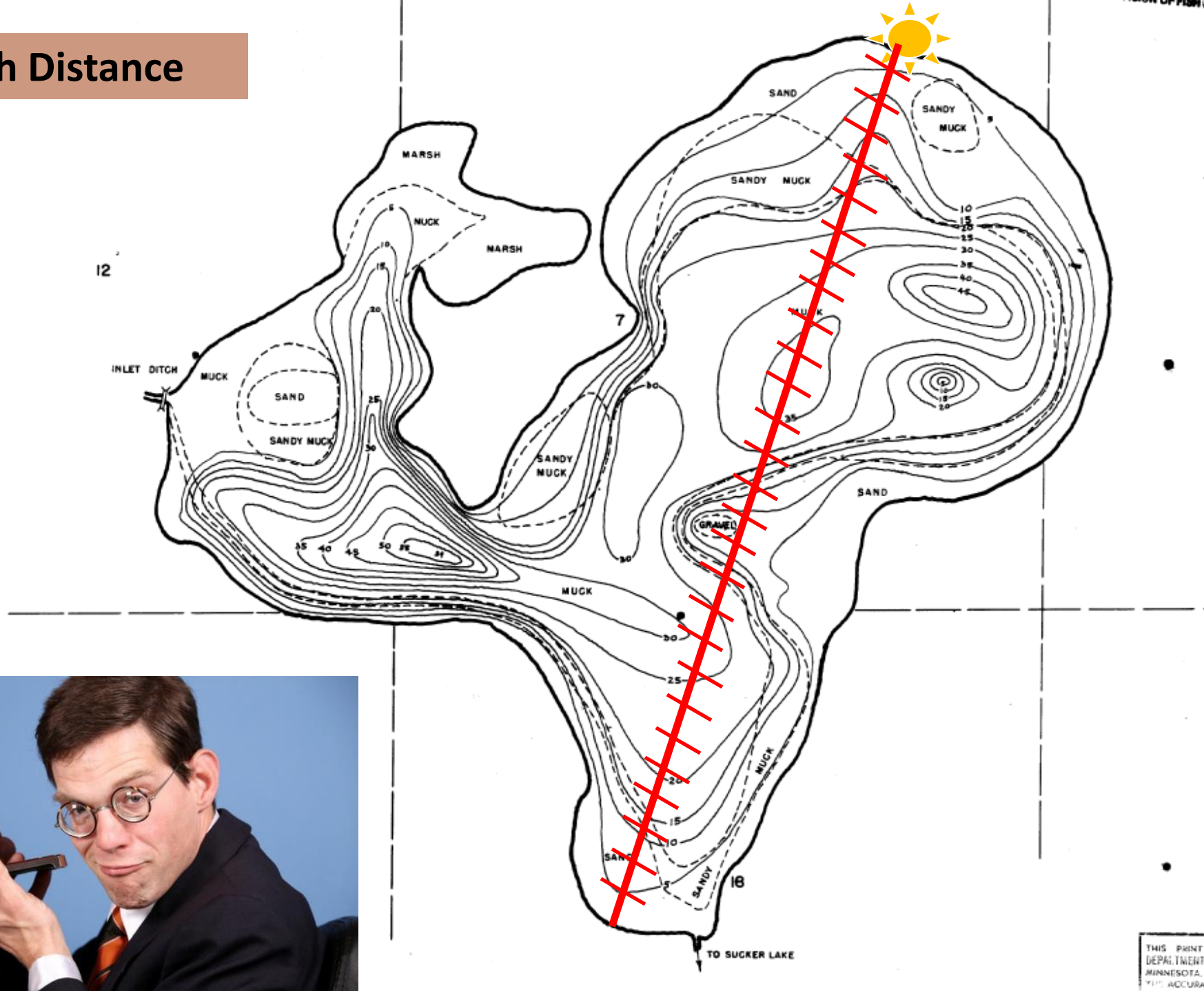
## Shoreline Energy

- Fetch distance
- bathymetry
- wake activity





# Fetch Distance



**Waterway and Wetland Permits**

[What's New](#)  
[Proposed Rules](#)  
[Public Hearings](#)  
[Workshops](#)  
[Permit Process](#)  
[Designated Waters Search](#)  
[Annual Report](#)  
[Why We Regulate](#)  
[Glossary of Terms](#)  
[Contacts by County](#)  
[Records Trial](#)

**Activities**

[Aquatic Plant Control](#)  
[Beaver Damage](#)  
[Beach Maintenance Activities \(PDF, 80Kb\)](#)  
[Boathouse Repair](#)  
[Boat Ramp \(Landings\)](#)  
[Boat Shelter](#)  
[Bridges](#)  
[Buoys](#)  
[Culverts](#)  
[Dams](#)  
[Dredging](#)  
[Dry Hydrants](#)  
[Fish or Wildlife Habitat](#)  
[Fords](#)  
[Grading](#)  
[Intake/Outfall Structure](#)  
[Irrigation](#)  
[Lake Levels](#)  
[Misc. Structures](#)  
[Nonmetallic Mining](#)

## Shoreline Erosion Control - Lakes

### Question

I am concerned about erosion along my lake or flowage shoreline. What should I do to protect the shoreline? Do I need to obtain a permit?

### Answer

Natural shoreline features provide erosion control in various ways.

Every shoreline is exposed to different natural events and human activities that can cause erosion. A small amount of soil erosion may not be a cause for any concern, but intervention may be needed on some shorelines.

If your property is on an inland lake or flowage, follow the steps below to assess your property, determine the extent of erosion, and get advice on the best range of methods for treating the shoreline. Permits will generally be required to place shoreline structures such as fiber logs, rock riprap or any type of seawall.

If your project is on a river or stream, see [Streambank Erosion Control](#).

All projects on the Great Lakes require an Individual Permit; if yours is such a project, go directly to [Step 7](#).

Because of their potential for harming fish and wildlife habitats and other public rights, the construction of seawalls along a shoreline is rarely permitted. Vegetative erosion control is recommended for low to moderate energy sites; for high energy sites, other structural methods such as rock riprap may be appropriate. For more information on erosion control methods, please see [Lakeshore and Streambank Erosion Control Information](#).



### Follow the steps below before starting your project.

1. [Calculate the energy along your shoreline.](#)
2. [Choose an appropriate Shoreline Erosion Control method for your shoreline's energy.](#)
3. [Determine if your waterway has a special designation that might affect the exemption or permit requirements.](#)
4. [Determine if your project is exempt.](#)
5. [Determine if your project qualifies for a General Permit.](#)
6. [Apply for a General Permit.](#)
7. [Apply for an Individual Permit.](#)

### Step 1: Calculate the energy along your shoreline

Engineers have determined that, of the factors that cause bank erosion, wind-driven waves are the predominant factor in determining the severity of erosion. This determination uses the longest fetch (distance that wind can blow waves across the lake to a site), the average depth along the fetch (depth determines the height waves can reach before breaking), and storm wind





## Calculating Energy Along a Shoreline

Follow these steps to obtain an accurate calculation of energy along your shoreline:

1. Print out the [map for your lakeshore site](#) (include the scale)
2. Figure out the correct feet-per-inch value using the map scale and your ruler, and enter the number below:  
1 inch =  feet
3. Mark your shoreline site on the lake map.
4. Draw the longest unobstructed straight line originating from your site across the water to any other point on the shore; this is the fetch at your site. Use [this example](#) [PDF, 289KB] for reference.
5. Using a ruler, measure the length of the fetch line and record this value:  
 inches
6. To convert the ruler measurement of fetch to actual distance, multiply feet per inch (found in step 2) by the measured fetch line (found in step 5):  
**Lake Fetch =  feet/inch x  inches = 0 feet**
7. Use the value (in feet) obtained from step 6 and divide by 5280 to convert Lake Fetch in feet to miles.  
For example Lake Fetch (ft)/5280
8. Measure the mean depth along your fetch line
  1. Locate and mark at least 5 equally-spaced points along your fetch line.
  2. Estimate and record the depths at these equally spaced points (for example: 45 ft, 105 ft, 75 ft, 55 ft and 25 ft).
  3. Add these depth values together and then divide by the number of sample points taken, and record the result. For example, (45 ft + 105 ft + 75 ft + 55 ft + 25 ft)/5 = 61 feet.)  
Use [this example](#) [PDF, 273KB] for reference.
9. Using the two values obtained in steps seven and eight, fetch from your site and mean depth on your fetch line, use the wind wave model below to calculate the storm wave height at your site. The storm wave height is used to determine the energy category at your site.

Mean Water Depth Along My Fetch	<input type="text" value="60"/>	feet
Lake Fetch From My Site	<input type="text" value="1.25"/>	miles
Storm Wind Speed	51.33	ft/sec

**Calculate**

<b>Storm Wave Height</b>	<b>1.15 feet</b>
<b>Energy Category</b>	<b>Moderate Energy</b>

# Shoreline Energy Classification

- Low Energy
  - Up to 1-foot of wave action
  - Appropriate bioengineering practices OK
- Medium Energy
  - From 1-2.3 feet of wave action
  - Combination of some bioengineering & hard armor
- High Energy
  - Greater than 2.3 feet of wave action
  - Hard armor only

# Additional Bank Stressors

- Soil type and slope (erosion resistance)
- Aspect (sun exposure)
- Ice sheet flows
- Groundwater piping
- Invasive species
- Herbivores
- Water turbidity

# ASSESSMENT

- Field
  - OHWL confirmation
  - Rapid stability assessment
  - Overland hydrology
  - Existing vegetation survey
  - Herbivore inspection
  - Cross sections

# ASSESSMENT

- Field
  - Sun exposure
  - Initial selection of stabilization
  - Potential habitat inclusion
  - Human values
  - Utilities
  - Base map completion



# **GUIDELINES FOR ORDINARY HIGH WATER LEVEL (OHWL) DETERMINATIONS**

---

by John Scherek and Glen Yakel

St. Paul, MN



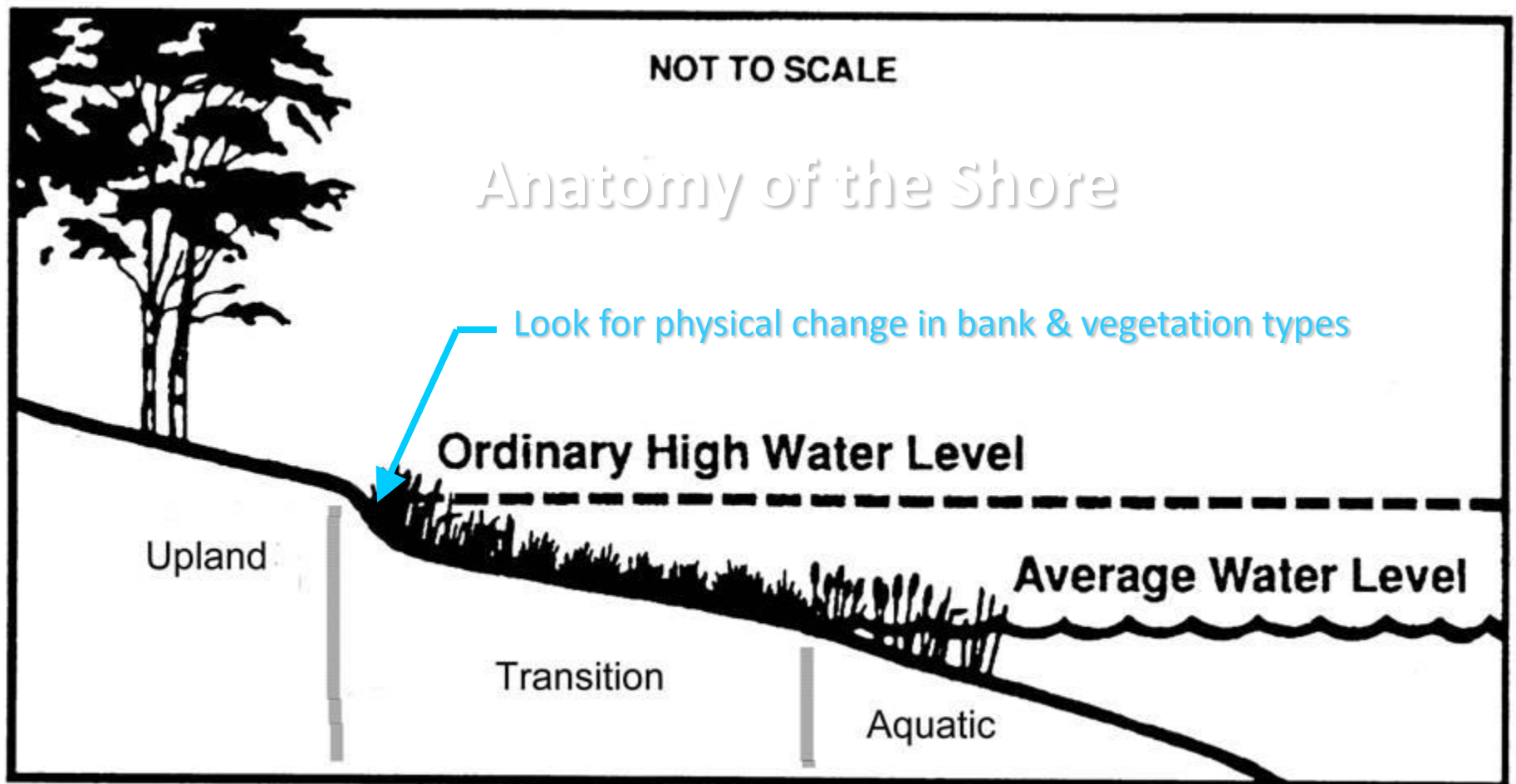
Technical Paper 11

Minnesota  
Department of Natural Resources  
Waters

June 1993

Any project constructed below the OHW mark, which alters the course, current or cross-section of protected waters or wetlands, is subject to the regulatory jurisdiction of the DNR.

For lakes and wetlands, the OHW is the highest water level which has been maintained for a sufficient period of time to leave evidence upon the landscape. The OHW is commonly that point where the natural vegetation changes from predominantly aquatic to predominantly terrestrial.



## Central Rich Dry Pine Woodland

Dry-mesic pine or hardwood woodlands on sandy, level to gently undulating outwash deposits or occasionally on sandy inclusions in rolling to hummocky stagnation moraines. Crown fires and mild surface fires were common historically.

## Vegetation Structure &amp; Composition

Description is based on summary of vegetation data from 45 plots (relevés).

• **Ground layer** is variable in cover, ranging from sparse to continuous (5–100% cover). Bracken (*Pteridium aquilinum*), Pennsylvania sedge (*Carex pensylvanica*), and mountain rice grass (*Oryzopsis asperifolia*) are often abundant. Other common species are Canada mayflower (*Maianthemum canadense*), northern bedstraw (*Galium boreale*), and common strawberry (*Fragaria virginiana*). Patches of moss are typical, with *Pleurozium schreberi* most commonly reported.

• **Shrub layer** is dense (often with > 75% cover); beaked hazelnut (*Corylus cornuta*), American hazelnut (*Corylus americana*), and bush honeysuckle (*Lonicera tunicata*) are usually abundant. Other common shrub or half-shrub species include prickly or smooth wild rose (*Rosa acicularis* or *R. blanda*), juneberrys (*Amelanchier* spp.), poison ivy (*Toxicodendron rydbergii*), and lowbush blueberry (*Vaccinium angustifolium*).

• **Subcanopy** is absent or poorly developed.

• **Canopy** is interrupted to continuous (50–100% cover), most commonly dominated by jack pine but occasionally dominated by red pine, quaking aspen, bur oak, or northern red oak.

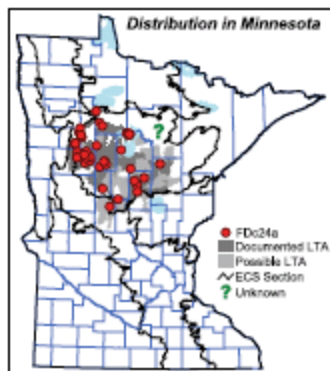
## Landscape Setting &amp; Soils

• **Outwash plains**—Common. Landscape is flat to rolling, with deep soils. Parent material is well-sorted sand, often with gravelly lenses but no large stones. Originally the parent material was calcareous, but free carbonates are now at least 30in (75cm) below the soil surface. Soil surface is somewhat dark to very dark in the upper 10in (25cm) because of incorporated organic matter, which indicates that these sites were formerly occupied by deciduous woodlands or prairies. Subsoil horizons that can perch snowmelt or rainfall are absent, although the organic-enriched surface horizons and complex textural banding in the lower horizons help to hold rainfall during the growing season. Soils are somewhat excessively drained. Soil-moisture regime is moderately dry to moderately fresh. (Chippewa Plains and Pine Moraines & Outwash Plains in MDL)

• **Stagnation moraines**—Occasional. Present on flat, local deposits of sand within otherwise hummocky or rolling landscapes. Originally the sandy parent material was calcareous, but free carbonates are now at least 60in (150cm) below the soil surface. Soil surface is somewhat darkened because of incorporated organic matter, which indicates that these sites were formerly occupied by deciduous brushland or woodland. The organic-enriched surface horizons and complex textural banding present in lower horizons help to hold rainfall during the growing season. Soils are well drained to somewhat excessively drained. Soil-moisture regime is moderately dry to moderately fresh. (Hardwood Hills in MIM, St. Louis Moraines and Pine Moraines & Outwash Plains in MDL)

## Natural History

In the past, fires were very common throughout the range of FDc24. An analysis of Public Land Survey records indicates that the rotation of catastrophic fires was about



130 years, and the rotation of mild surface fires about 30 years. The rotation of all fires combined is estimated to be 23 years. Windthrow was not common, with an estimated rotation exceeding 1,000 years. Based on the historic composition and age structure of these woodlands, FDc24 had three growth stages separated by two periods of transition.

• **0–55 years**—Young woodlands recovering from fire, strongly dominated by jack pine with red pine and quaking aspen present as minor components.

• **55–75 years**—A transition period marked by a partial decline in jack pine, mirrored by an increase in red pine. Northern red oak and bur oak, although minor components, peak during this period when present.

• **75–155 years**—Mature woodlands dominated by jack pine mixed with red pine. Cohorts of younger red pine and jack pine are characteristic in the understory, becoming established following mild surface fires.

• **155–195 years**—A transition period marked by a sharp decline in red pine and a modest decline in jack pine, mirrored by an increase in white pine.

• **> 195 years**—Very old forests dominated by jack pine of several age classes. White pine and some old red pines are present as supercanopy trees. (Jack pine and white pine are rarely present together in contemporary old forests. The apparent discrepancy between historic and contemporary old-forest composition may be an artifact of having too few samples of very old forests. Alternatively, it may have been possible for jack pine to grow among scattered white pines and old red pines on sites with rich sandy soils, which are now mostly farmland.)

## Similar Native Plant Community Classes

## • FDc25 Central Dry Oak-Aspen (Pine) Woodland

FDc25 is the class most similar to FDc24, especially when dominated by jack pine (FDc25a). FDc25 generally occurs to the south and east of FDc24 on sandy glacial river terraces in the St. Croix River valley, but the ranges of the two classes overlap in central Minnesota. FDc25 is more likely to have species characteristic of open jack pine barrens communities (including those common to the east in Wisconsin), while FDc24 is more likely to have species characteristic of closed-canopy FDN communities.

FDc24 Indicator Species	(freq%) FDc24	(freq%) FDc25	FDc25 Indicator Species	(freq%) FDc24	(freq%) FDc25
Beaked hazelnut ( <i>Corylus cornuta</i> )	78	-	Big bluestem ( <i>Andropogon gerardii</i> )	-	50
Early meadow rue ( <i>Thymidrum dictamnus</i> )	75	-	Little bluestem ( <i>Schizachyrium scoparium</i> )	-	50
Blue giant hyacinth ( <i>Agastache foeniculum</i> )	42	-	Sweet fern ( <i>Comptonia perfoliata</i> )	-	25
Twinklflower ( <i>Lonicera borealis</i> )	31	-	Wild bergamot ( <i>Monarda fistulosa</i> )	2	63
Red pine (C.U.)	29	-	Northern pin oak (C.U.)	4	100
Red raspberry ( <i>Rubus idaeus</i> )	69	13	Woodland sunflower ( <i>Helianthus strumosus</i> )	4	63
Wild sunflower ( <i>Anolis nudicaulis</i> )	69	13	Sharp-pointed rice grass ( <i>Oryzopsis pungens</i> )	4	50
Large-leaved aster ( <i>Aster macrophyllus</i> )	62	13	Wintergreen ( <i>Geotheca procumbens</i> )	24	75

## • FDc34 Central Dry-Mesic Pine-Hardwood Forest

FDc34 can be similar to FDc24 but is usually dominated by red pine or white pine with jack pine only of minor importance. FDc34 is more likely to have species (including red and white pine) that occur on sites where relatively fine-textured and rich soils are within the reach of deeper rooting plants. FDc24 is more likely to have species present on the relatively poor soils typically derived from deep deposits of sand and gravel.

FDc24 Indicator Species	(freq%) FDc24	(freq%) FDc34	FDc34 Indicator Species	(freq%) FDc24	(freq%) FDc34
Paspalum ( <i>Artemisia</i> spp.)	18	-	Large-flowered bellwort ( <i>Uvularia grandiflora</i> )	2	51
Heavy grasses ( <i>Liatris pycnostachya</i> )	11	-	White pine (C)	4	46
Blue giant hyacinth ( <i>Agastache foeniculum</i> )	42	2	Red maple (C)	4	34
Jack pine (C.U.)	54	17	Fly honeysuckle ( <i>Lonicera canadensis</i> )	4	27
Pin cherry ( <i>Prunus pensylvanica</i> )	33	7	Rose hawthorn ( <i>Strawberry rose</i> )	11	66
Ernst, Smooth, or Illinois cation-flower*	18	5	Round-leaved dogwood ( <i>Cornus rugosa</i> )	11	44
Prairie willow ( <i>Salix humilis</i> )	62	20	Bunchberry ( <i>Cornus canadensis</i> )	11	39
Paspalum ( <i>Chamaelirium umbellatum</i> )	26	7	Blueberry fly ( <i>Clintonia borealis</i> )	13	46

\*Ernst, Smooth, or Illinois cation-flower (*Smilax acuta*, *S. herbacea*, or *S. illinoensis*)

## • FDc23 Central Dry Pine Woodland

FDc23 is somewhat similar to FDc24 but occurs on sand deposits that have had a longer history of conifer cover; as a result, the soils of FDc23 are poorer in nutrients and have lower organic material content in the upper horizons. FDc23 is much more likely to have species characteristic of prairie habitats.





## FDc24 Central Rich Dry Pine Woodland – Species Frequency & Cover



	freq%	cover		freq%	cover				
<b>Forbs, Ferns &amp; Fern Allies</b>			<b>Low Shrubs</b>						
Canada mayflower ( <i>Maianthemum canadense</i> )	96	••	Lowbush blueberry ( <i>Vaccinium angustifolium</i> )	80	••				
Common strawberry ( <i>Fragaria virginiana</i> )	87	•	Red raspberry ( <i>Rubus idaeus</i> )	69	••				
Northern bedstraw ( <i>Galium boreale</i> )	87	•	Tall blackberries ( <i>Rubus allegheniensis</i> and similar <i>Rubus</i> spp.)	29	••				
Early meadow-rue ( <i>Thalictrum dioicum</i> )	73	•	Wintergreen ( <i>Gaultheria procumbens</i> )	24	•				
Wood anemone ( <i>Anemone quinquefolia</i> )	69	•	Pipsissewa ( <i>Chimaphila umbellata</i> )	20	•				
Wild sarsaparilla ( <i>Aralia nudicaulis</i> )	69	••	<b>Shrubs</b>						
Bracken ( <i>Pteridium aquilinum</i> )	64	•••	Juneberry ( <i>Amelanchier</i> spp.)	87	••				
Large-leaved aster ( <i>Aster macrophyllus</i> )	62	••	Poison ivy ( <i>Toxicodendron rydbergii</i> )	84	••				
Sweet-scented bedstraw ( <i>Galium triflorum</i> )	56	•	Prickly or Smooth wild rose ( <i>Rosa acicularis</i> or <i>R. blanda</i> )	82	•				
Pale vetchling ( <i>Lathyrus ochroleucus</i> )	56	•	Beaked hazelnut ( <i>Corylus cornuta</i> )	78	••••				
Spreading dogbane ( <i>Apocynum androsaemifolium</i> )	56	•	American hazelnut ( <i>Corylus americana</i> )	76	•••				
One-sided pyrola ( <i>Pyrola secunda</i> )	53	•	Chokeberry ( <i>Prunus virginiana</i> )	76	••				
Lindley's aster ( <i>Aster ciliolatus</i> )	51	•	Bush honeysuckle ( <i>Dicentra bicolor</i> )	71	•••				
Blue giant hyssop ( <i>Agastache foeniculum</i> )	42	•	Snowberry or Wolfberry ( <i>Symphoricarpos albus</i> or <i>S. occidentalis</i> )	71	•				
American vetch ( <i>Vicia americana</i> )	40	•	Prairie willow ( <i>Salix humilis</i> )	62	•				
Dwarf raspberry ( <i>Rubus pubescens</i> )	40	•	Downy arrowwood ( <i>Viburnum rafinesquianum</i> )	44	••				
Maryland black snakeroot ( <i>Sambucus marilandica</i> )	40	•	Pin cherry ( <i>Prunus pennsylvanica</i> )	33	•				
Pale bellwort ( <i>Uvularia sessilifolia</i> )	36	•	Graydogwood ( <i>Cornus racemosa</i> )	24	••				
Twinnflower ( <i>Linnaea borealis</i> )	31	••	Hawthorn ( <i>Crataegus</i> spp.)	18	•				
Veiny pea ( <i>Lathyrus venosus</i> )	31	•							
Starflower ( <i>Trentalia borealis</i> )	27	•	<b>Trees</b>						
Clayton's sweet cicely ( <i>Osmorhiza claytonii</i> )	27	•		Canopy	Subcanopy	Shrub Layer			
Columbine ( <i>Aquilegia canadensis</i> )	24	•		freq% cover	freq% cover	freq% cover			
Spinulose shield fern or Glandular wood fern*	20	•	Jack pine	84	••••	11	•••	-	-
Round-leaved hepatica ( <i>Anemone americana</i> )	18	•	Quaking aspen	31	•••	33	••	42	•
Smooth camellion-flower ( <i>Smilax herbacea</i> )	18	•	Red pine	29	•••	11	•	-	-
Round-leaved pyrola ( <i>Pyrola rotundifolia</i> )	18	•	Paper birch	27	•••	20	•	16	•
<b>Grasses &amp; Sedges</b>			Bur oak	24	•••	56	••	64	•
Mountain rice grass ( <i>Oryzopsis asperifolia</i> )	84	•••	Northern red oak	18	•••	49	••	71	•
Pennsylvania sedge ( <i>Carex pensylvanica</i> )	71	•••	Black cherry	-	-	29	•	27	•
False melic grass ( <i>Schizachne purpurascens</i> )	36	••	Red maple	-	-	20	•	29	•
<b>Climbing Plants</b>			Green ash	-	-	11	•	24	•
Virginia creeper ( <i>Parthenocissus</i> spp.)	33	•	Big-toothed aspen	-	-	11	•	11	•
Wild honeysuckle ( <i>Lonicera dioica</i> )	20	•	Balsam fir	-	-	9	••	22	•
			White pine	-	-	9	••	18	•

\* Spinulose shield fern or Glandular wood fern (*Dryopteris carthusiana* or *D. intermedia*)




[Home](#)[Easements](#)[Grants](#)[Resource Management  
and Planning](#)[Conservation  
Implementation](#)[Wetlands](#)

## Native Vegetation / Seed Mixes



### BW&R Policy

- [BW&R Native Vegetation Establishment and Enhancement Guidelines](#)  (posted Dec. 23, 2009)
- [Questions and Answers](#)
- [Vegetative Management and Enhancement of Conservation Easement Lands](#)  (Dec. 17, 2005)


### Seed Mixes

- [Summary of Seed Mixes](#)  (Index of names and numbers - Posted March 15, 2010)
- [State Seed Mixes](#)  (Includes mixes used by Minn. Dept. of Transportation - Posted March 15, 2010)
- [Substitution Table](#)  (List of species that may be substituted in state seed mixes - Posted March 15, 2010)

### Native Vegetation Establishment and Enhancement

- [Recommended Seeding Dates for Restoration Projects](#)  (posted March 15, 2010)
- [Guidelines for Inter-seeding Grasslands to Restore or Enhance Native Species Diversity](#) 
- [What's Working - feedback from BW&R grant recipients and other conservation professionals on effective methods of establishing native vegetation for conservation projects](#)

### Maps

- [Map of Minnesota Ecological Sections and Subsections](#)  (posted Oct. 14, 2009)

### BW&R Publications

- [Planting and Maintenance Recommendations for Wetland Restoration and Buffer Projects](#)  (July 2010)
- [Wetland Restoration Plant ID Guide \(USDA NRCS - BW&R publication\)](#)
- [Minnesota Wetland Restoration Guide - Vegetation Establishment Section](#) 
  - [Appendices related to native vegetation:](#)
    - [A - Invasive Species Control Information](#)
    - [B - Project Specifications](#)
    - [C - Restoration Details/Diagrams](#)
    - [D - Seed Bank Testing Protocol](#)
    - [E - Plant Community Tables](#)
    - [F - Vegetation Establishment Tables](#)
    - [G - Vegetation Establishment Research Needs](#)
    - [H - Plant Information Links](#)
    - [I - Vegetation Plant Examples](#)
    - [J - Citations](#)




### PCA Publications

[Plants for Stormwater Design Volume 1](#)


### Federal Agency Publications

- [Wetland Plants and Plant Communities of Minnesota and Wisconsin](#)
- [A Soil Bioengineering Guide for Streambank and Lakeshore Stabilization](#)

### Other Resources

Other suggested web sites: [Restore Your Shore](#)  and [Minnesota's Native Plant Communities](#)  at [DNR web site](#) and [Species Lists for Native Plant Communities in east-central Minnesota at Great River Greening](#)  web site.

### Minnesota Board of Water and Soil Resources

210 Lafayette Road North, St. Paul, MN 55112 | [651-295-2767](tel:651-295-2767)  | [651-297-2415](tel:651-297-2415) (TTY) (800) 627-3229

An Equal Opportunity Employer

[Web site viewing tips](#)

[E-mail webmaster](#)

[Job Postings](#)






### Native Seed Vendor

Prairie Moon Nursery and Shooting Star Native Seeds are the vendors under contract to supply state seed mixes for restoration projects and best management practices. State agencies and any local units of government that are members of the state cooperative purchasing venture can purchase off of the contract.

More information about state of Minnesota cooperative purchasing opportunities is available on the website of Minnesota's Materials Management Division.

Purchases may be done by direct purchase order (DPO) to the vendor.

**PRAIRIE MOON NURSERY**  
Contract Number 437854  
VENDOR NO.: 200485259 00  
COMMODITY CODE NO.: 374-01-00000  
PHONE: [866-467-8155](tel:866-467-8155) 

**SHOOTING STAR NATIVE SEEDS**  
Contract Number 437855  
VENDOR NO.: [888-525-6996](tel:888-525-6996)   
COMMODITY CODE NO.: 374-01-00000  
PHONE: [507-498-2844](tel:507-498-2844) 

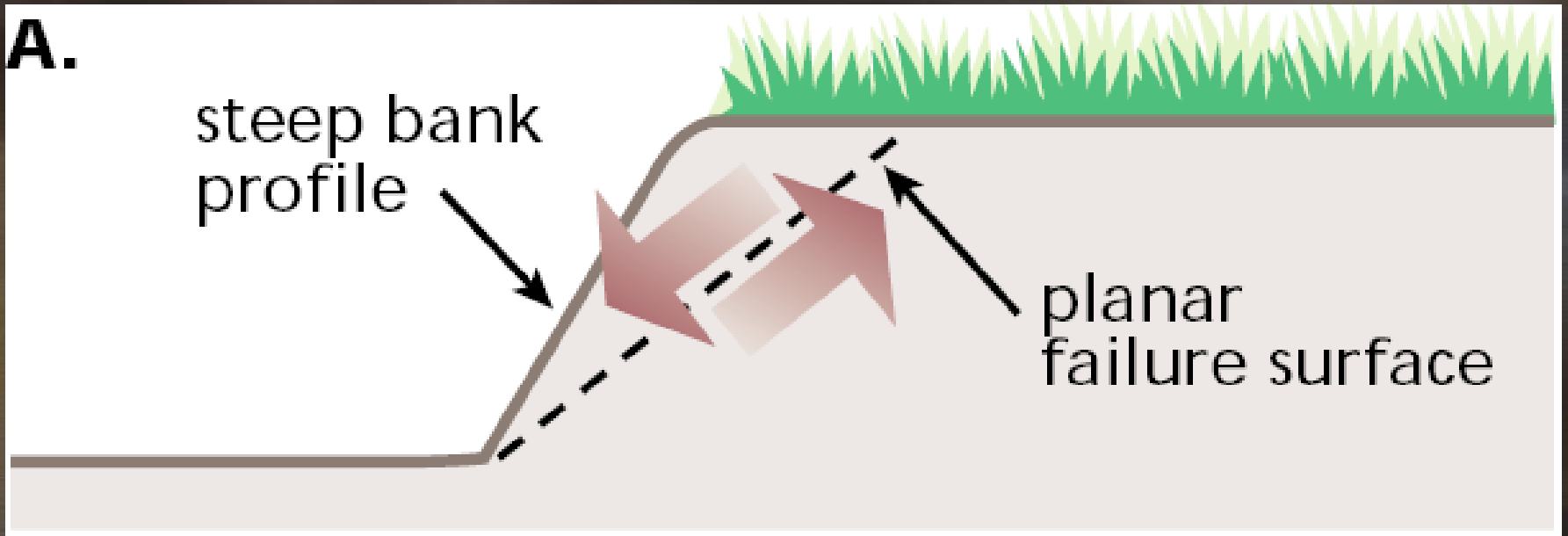
Other vendors are available across the state that can meet state guidelines for native vegetation seed mixes. To find a vendor, please see [Native plant suppliers and landscapers in Minnesota on the DNR website](#).



**A.**

steep bank  
profile

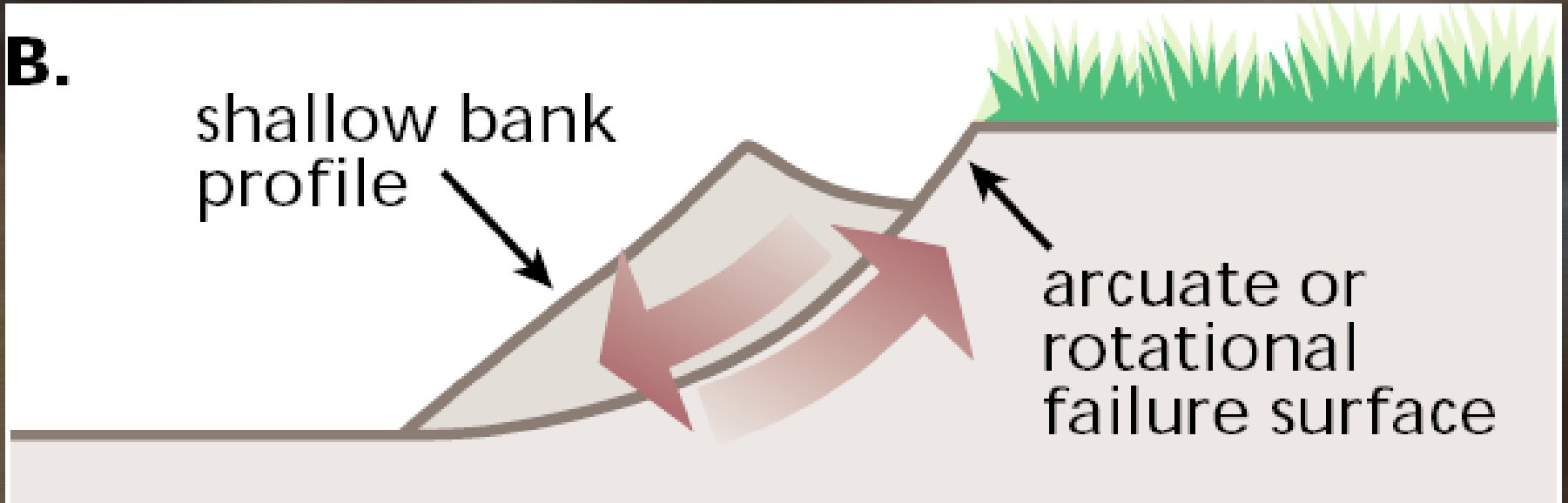
planar  
failure surface



**B.**

shallow bank  
profile

arcuate or  
rotational  
failure surface



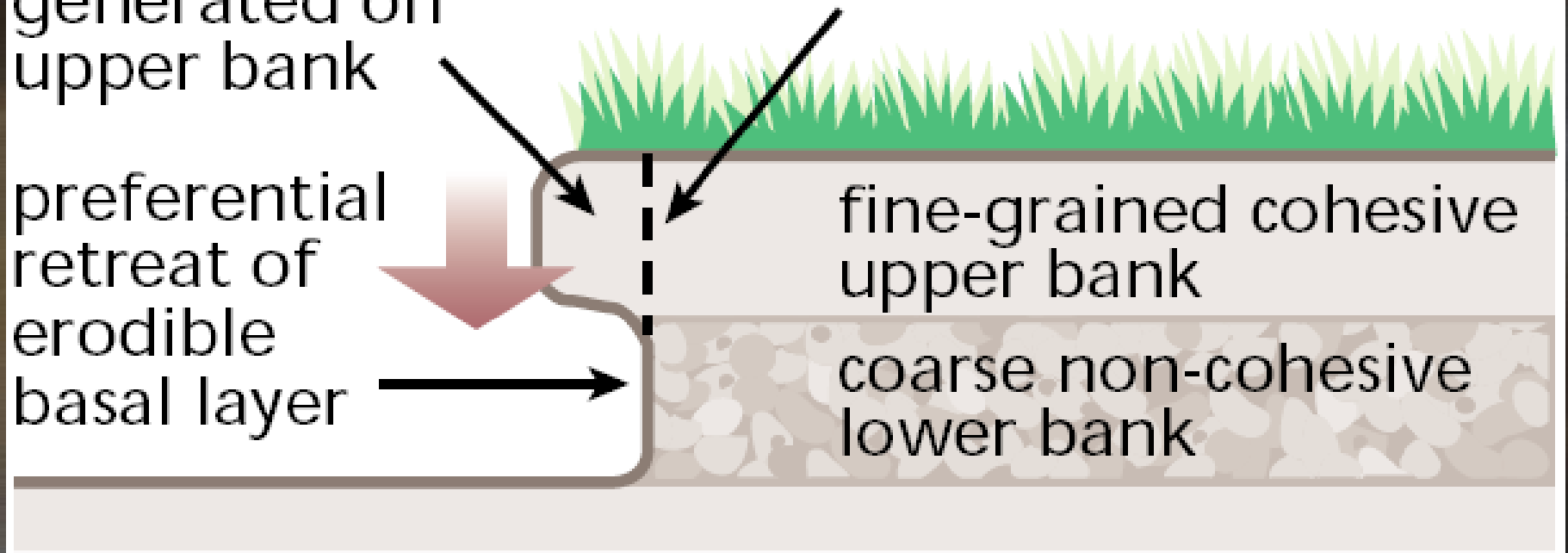
overhang  
generated on  
upper bank

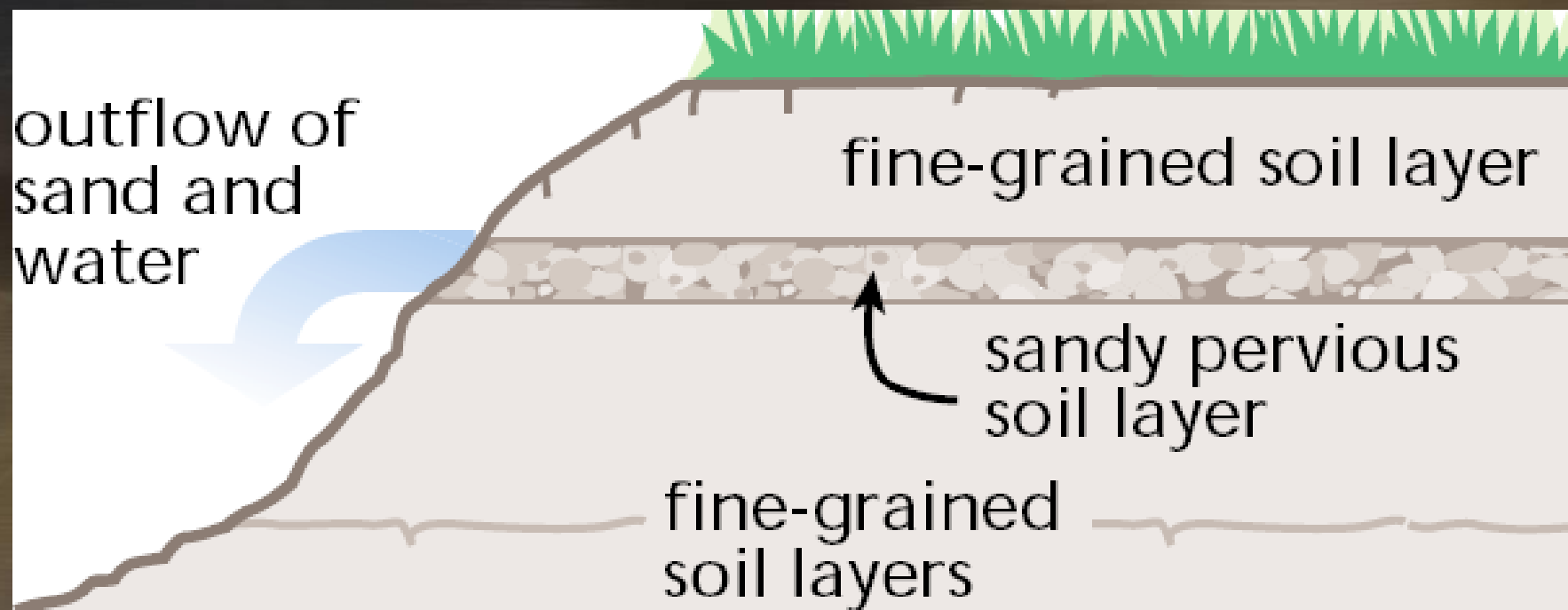
preferential  
retreat of  
erodible  
basal layer

incipient failure plane

fine-grained cohesive  
upper bank

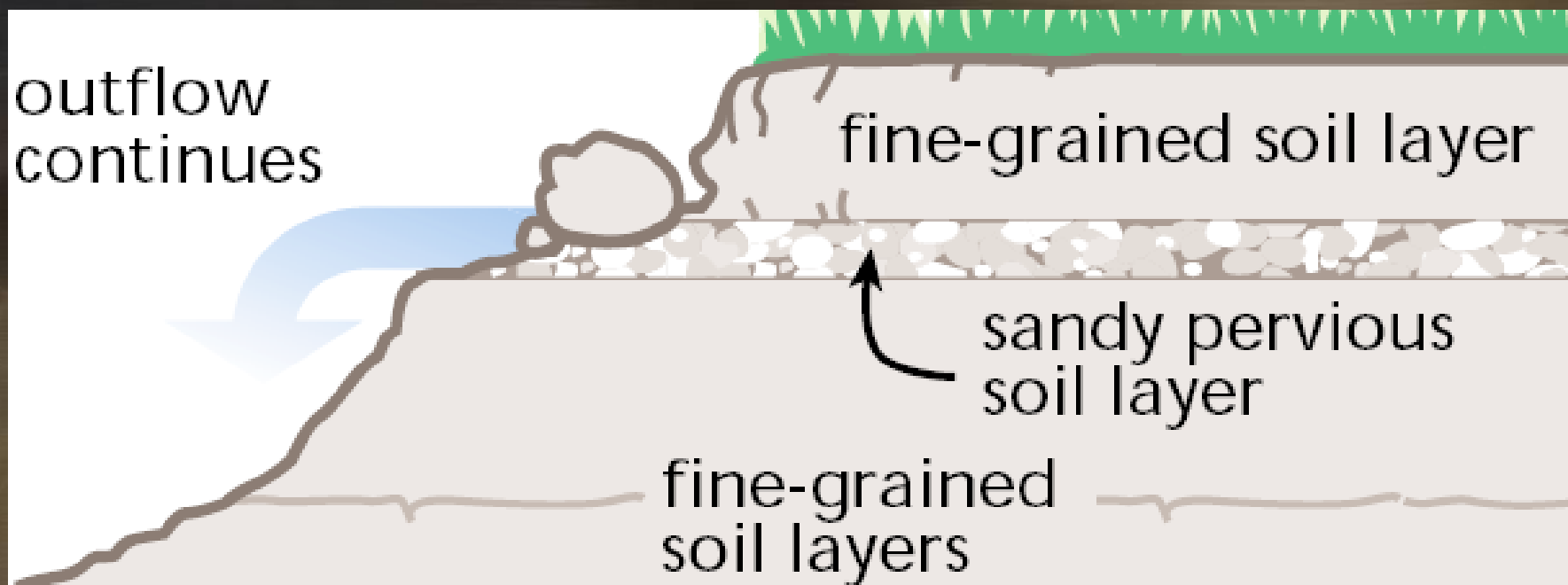
coarse non-cohesive  
lower bank



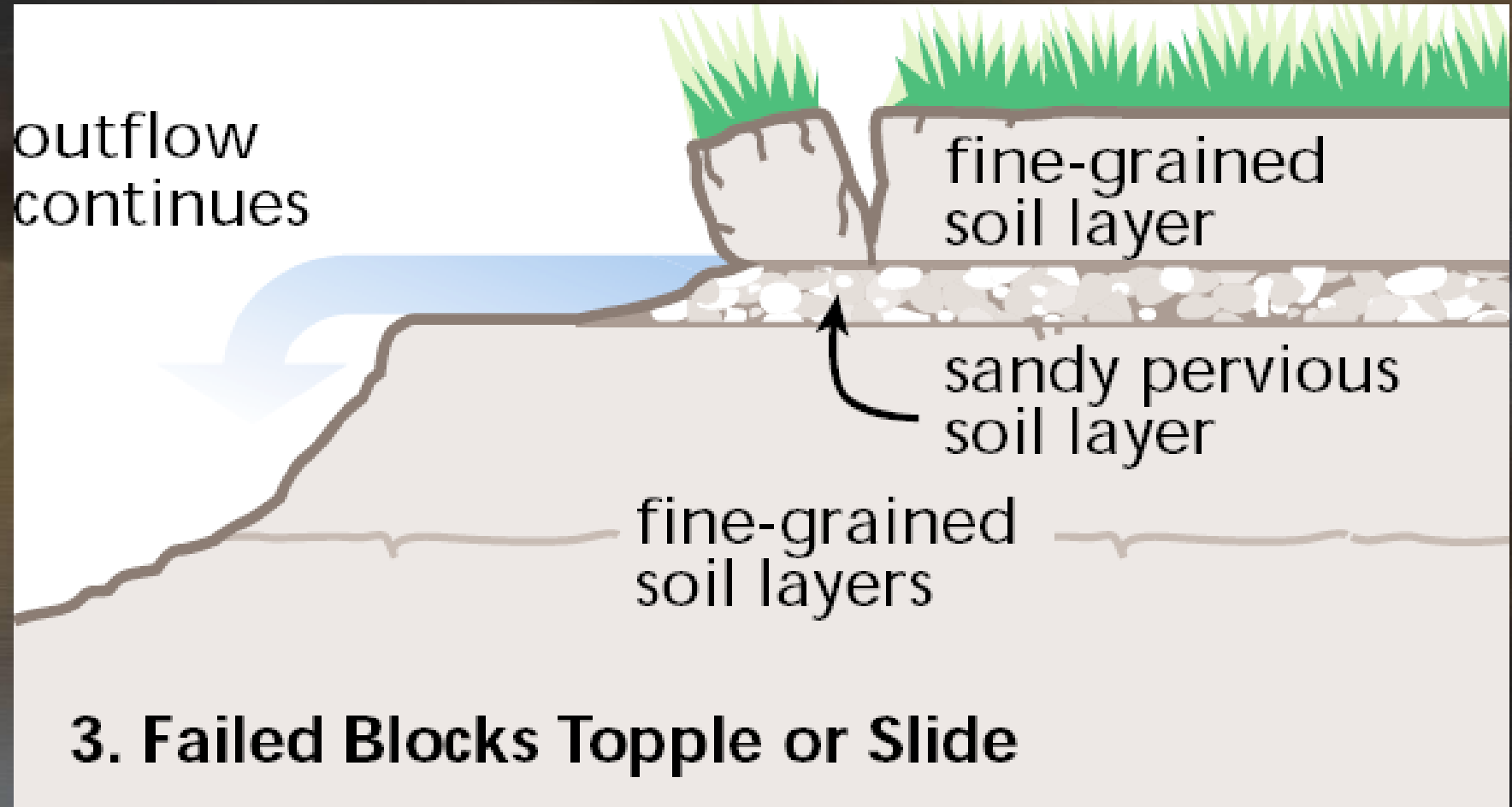


## 1. Seepage Outflow Initiates Soil Loss





## 2. Undermined Upper Layer Falls, Blocks Detached



## LAKE NOTES

Fetch Distance = 6200 ln ft

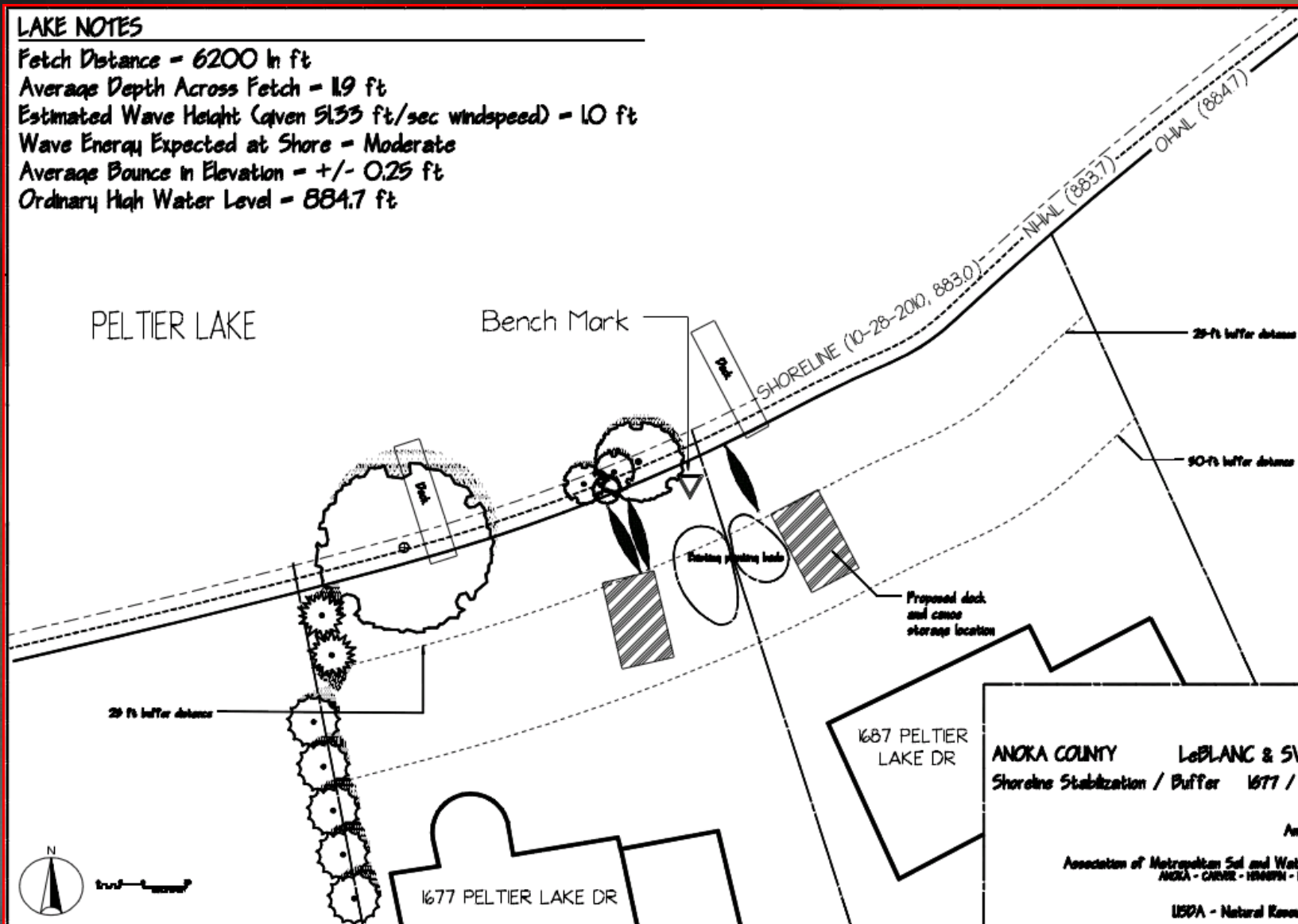
Average Depth Across Fetch = 11.9 ft

Estimated Wave Height (given 51.33 ft/sec windspeed) = 10 ft

Wave Energy Expected at Shore = Moderate

Average Bounce in Elevation = +/- 0.25 ft

Ordinary High Water Level = 884.7 ft



Concept Plan  
Sheet 1 of 1

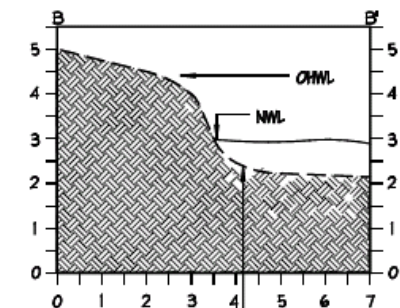
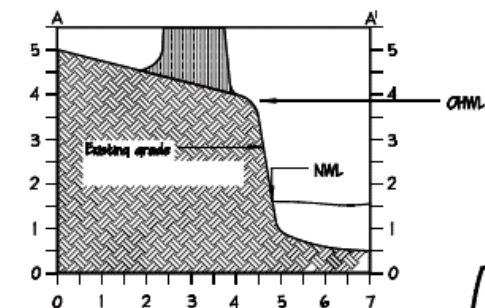
ANKA COUNTY LeBLANC & SVELTIN RESIDENCE

Shoreline Stabilization / Buffer 1677 / 1687 PelTier Lake Dr,  
Centerville, MN

prepared by  
Anoka Conservation District

In cooperation with  
Association of Metropolitan Soil and Water Conservation Districts  
ANKA - CARVER - HENNING - RAINY - SCOTT - WASHINGTON

and the  
USDA - Natural Resource Conservation Service



Existing grade

Existing Arborvitas (keep)

Dock Storage Area



Existing invasive shrubs (remove)

Existing Willow (keep)

Cross Section

LAKE

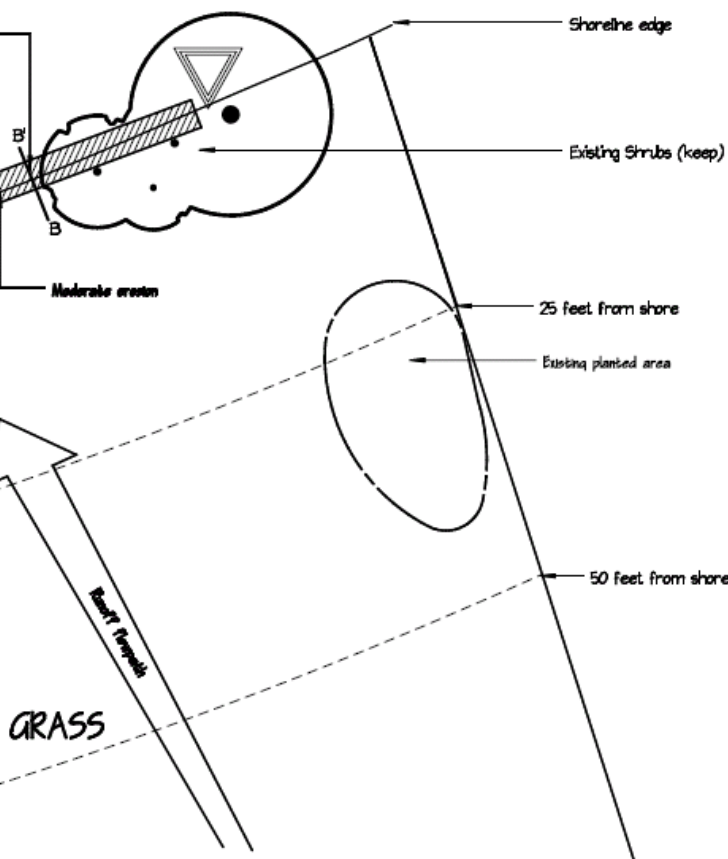
Major erosion

Shrub Removal

SPARSE TURF GRASS

HOUSE

SCALE IN FEET



**LAKESHORE PLAN**  
**LeBLANC SHORELINE**  
 1677 Pettier Lake Dr, Centerville, MN

ANOKA COUNTY  
 Prepared by: Prepared by  
 Anoka Conservation District  
 in association with  
 Association of Metropolitan Soil and Water Conservation Districts  
 and the  
 USDA - Natural Resource Conservation District

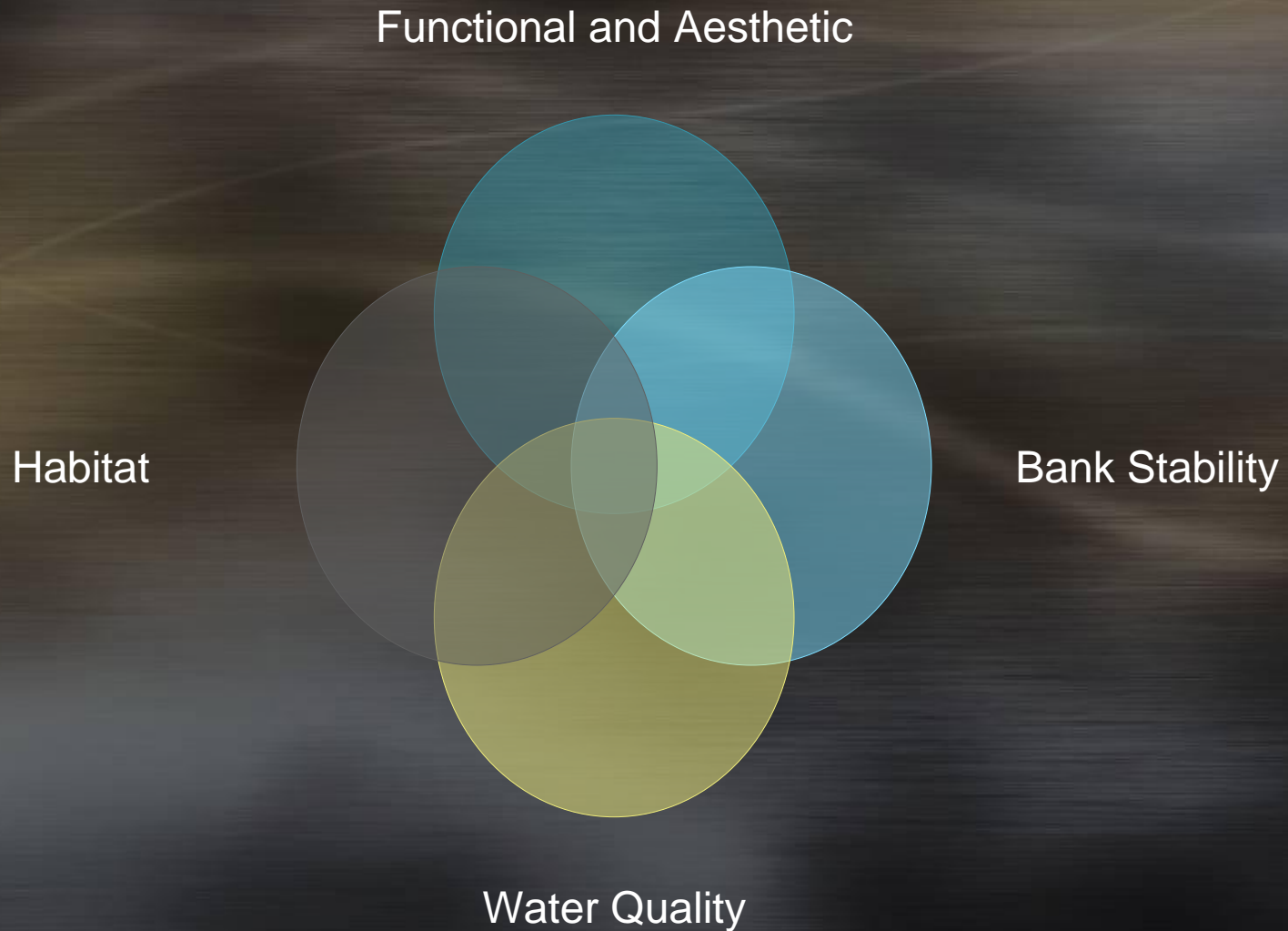
Date 5-1-09  
 Sheet 1  
 Revision  
 Scale 1-in = 10 ft



# DESIGN

- Phasing considerations
- Conceptual layout plan
- Stabilization plan
- Bioengineering and/or armoring plan
- Layout plan
- Planting plan

# Site-Specific Goals and Stressors Drive Design Type, Complexity and Cost

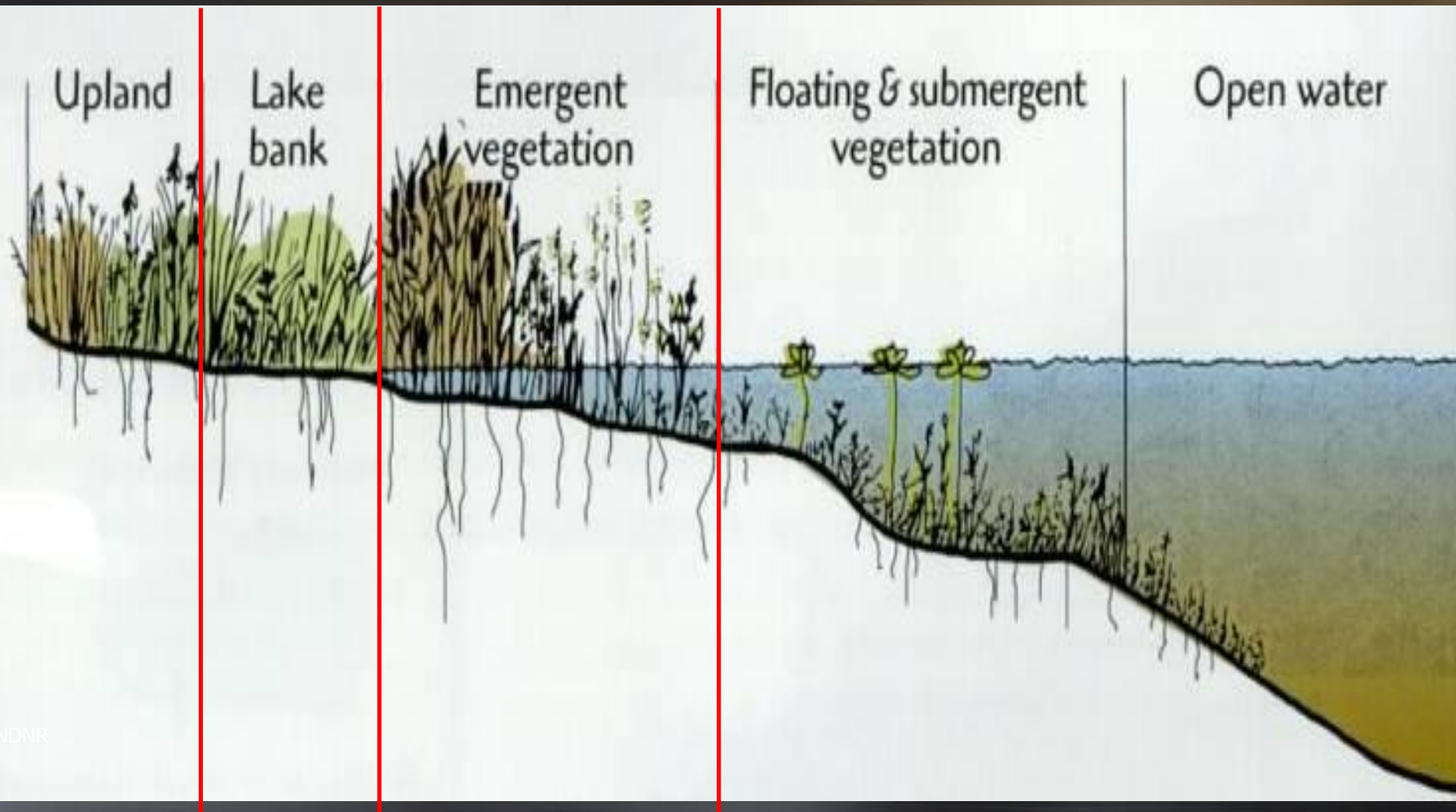


## Buffer Zone



Source: Lakescaping for Wildlife and Water Quality

*Just inside the buffer zone is a small depression that guides stormwater draining from the yard to the rainwater garden near the lake. Within the rainwater garden, stormwater runoff soaks into the ground and filters through the soil before reaching the lake.*



Upland

Lake  
bank

Emergent  
vegetation

Floating & submergent  
vegetation

Open water

Upland

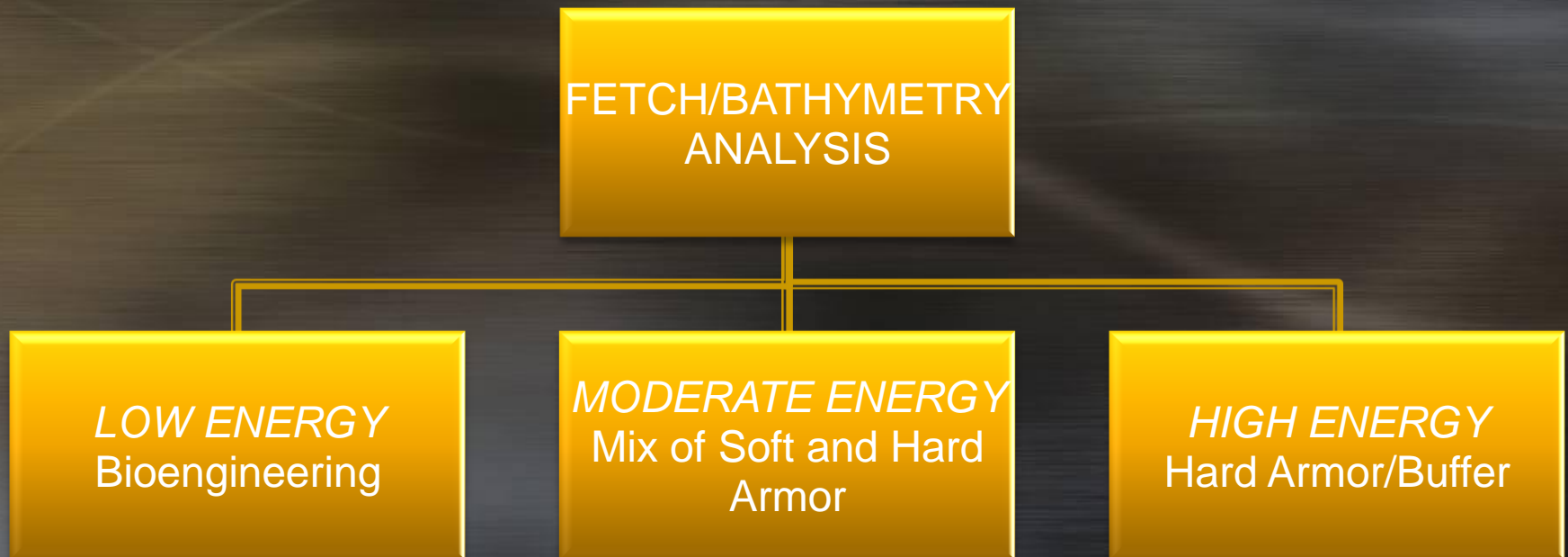
Transitional

Emergent

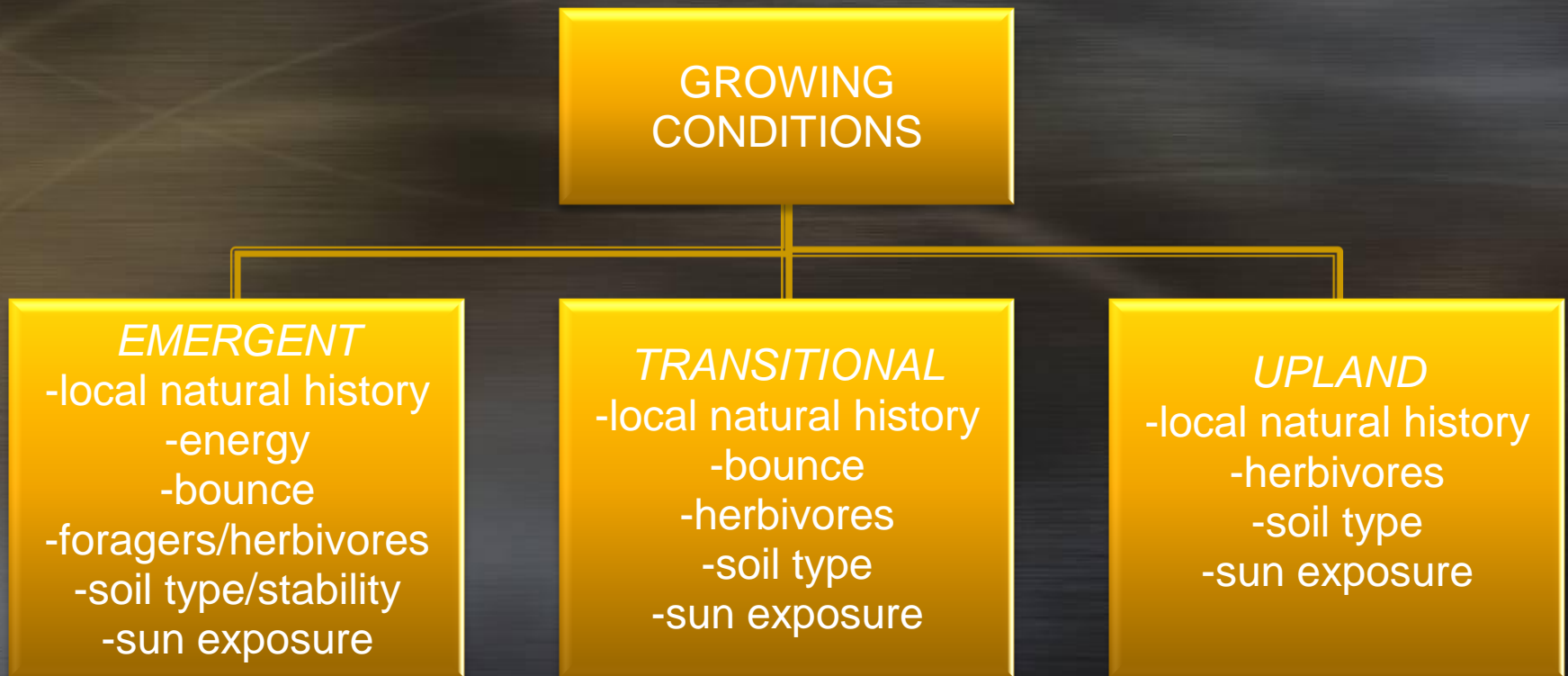
MNDNR



# Choosing the Right Approach for Bank Stabilization



# Choosing the Right Approach for Vegetation Establishment





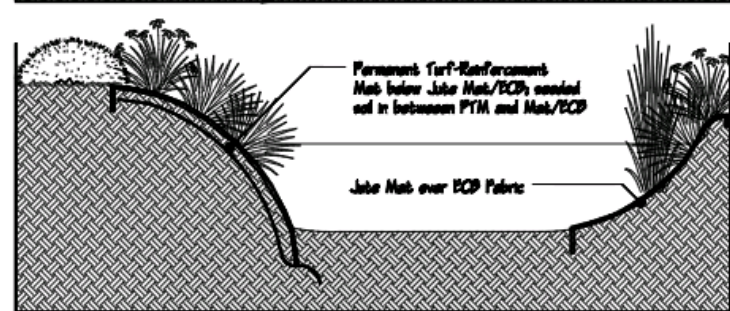
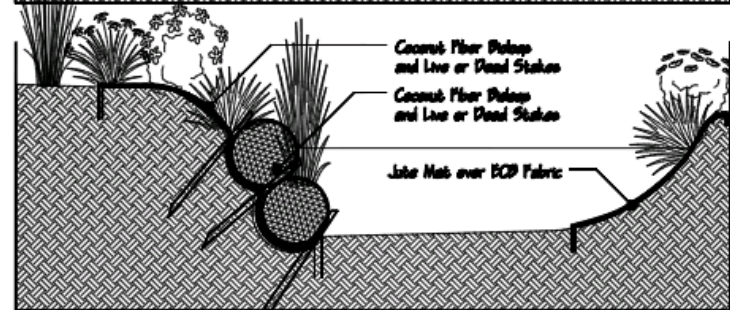
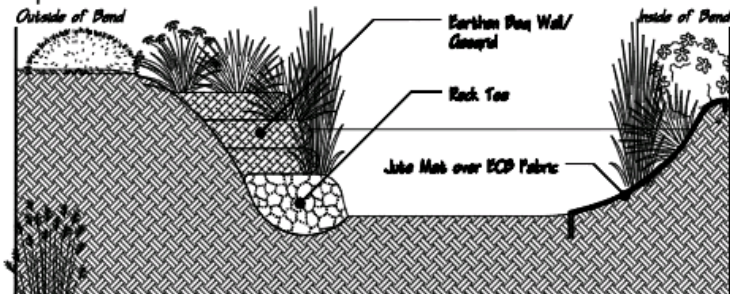




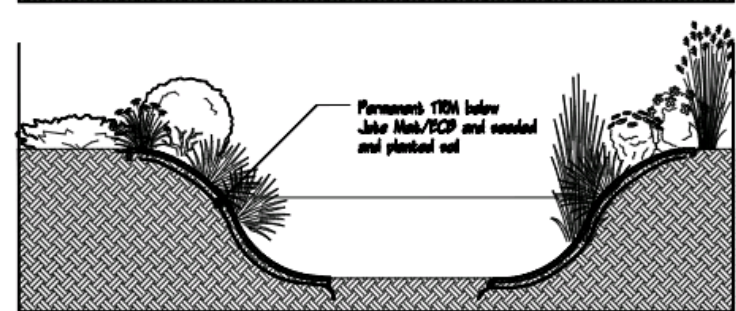
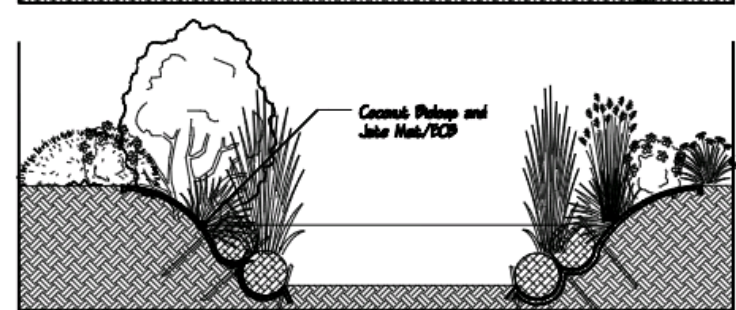
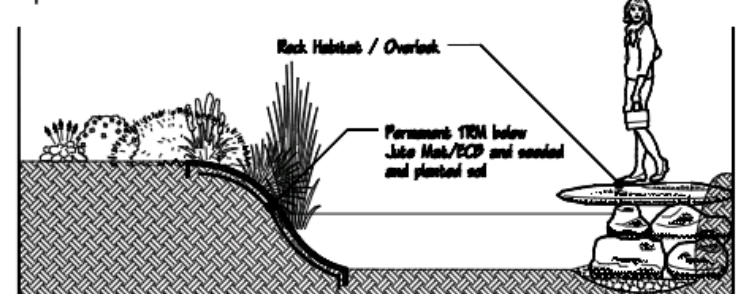




## Options for Bends



## Options Between Bends



### BERGREN TROUT STREAM CONCEPTS

Bergren Residence  
504-45 Valley Creek Trail 5  
Afton, MN

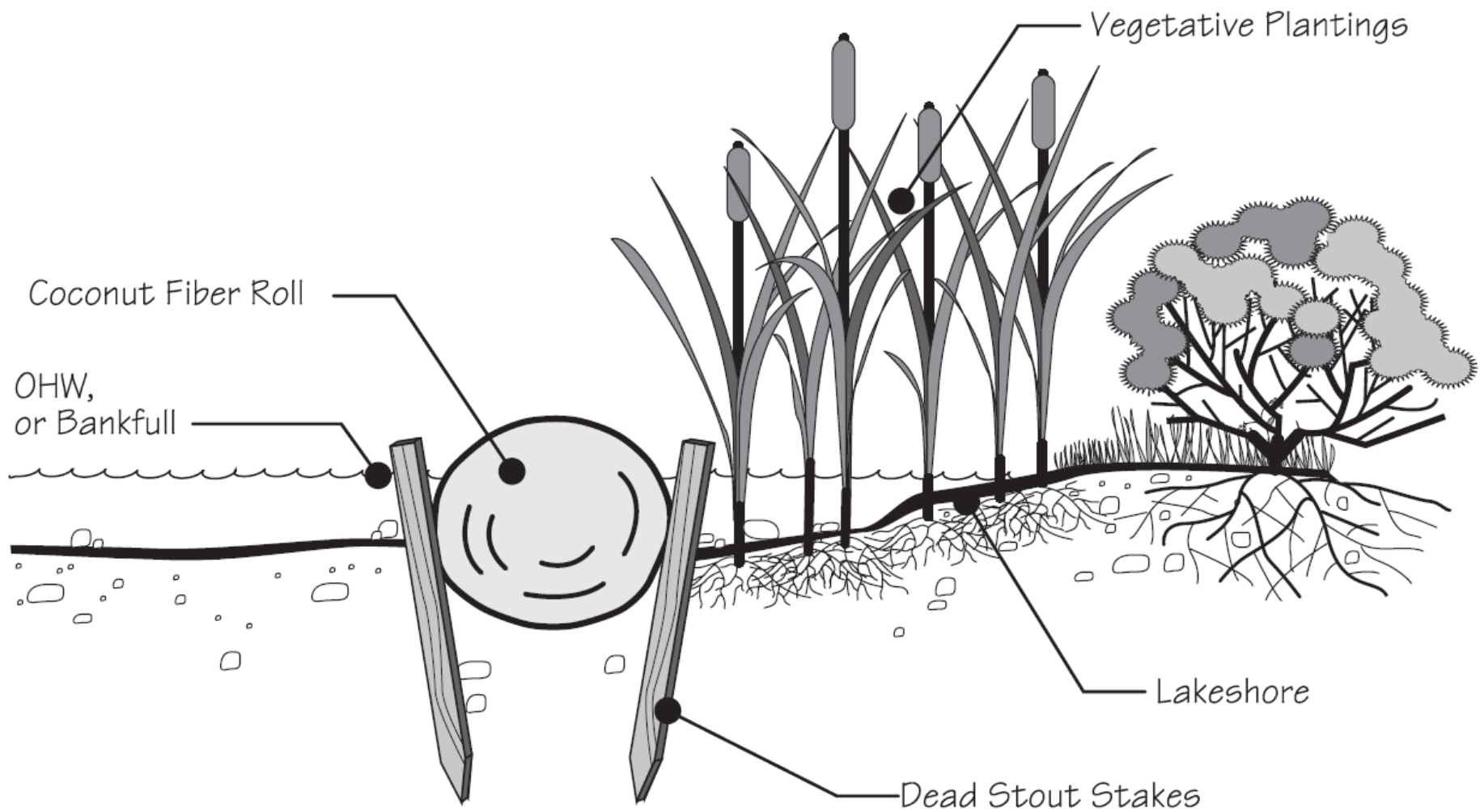
designed by  
Washington Conservation District

in cooperation with  
Association of Metropolitan Soil and Water Conservation Districts  
and the  
USDA - Natural Resource Conservation Service

NOTE: Channel form and final grades to be determined. For concept planning purposes only.





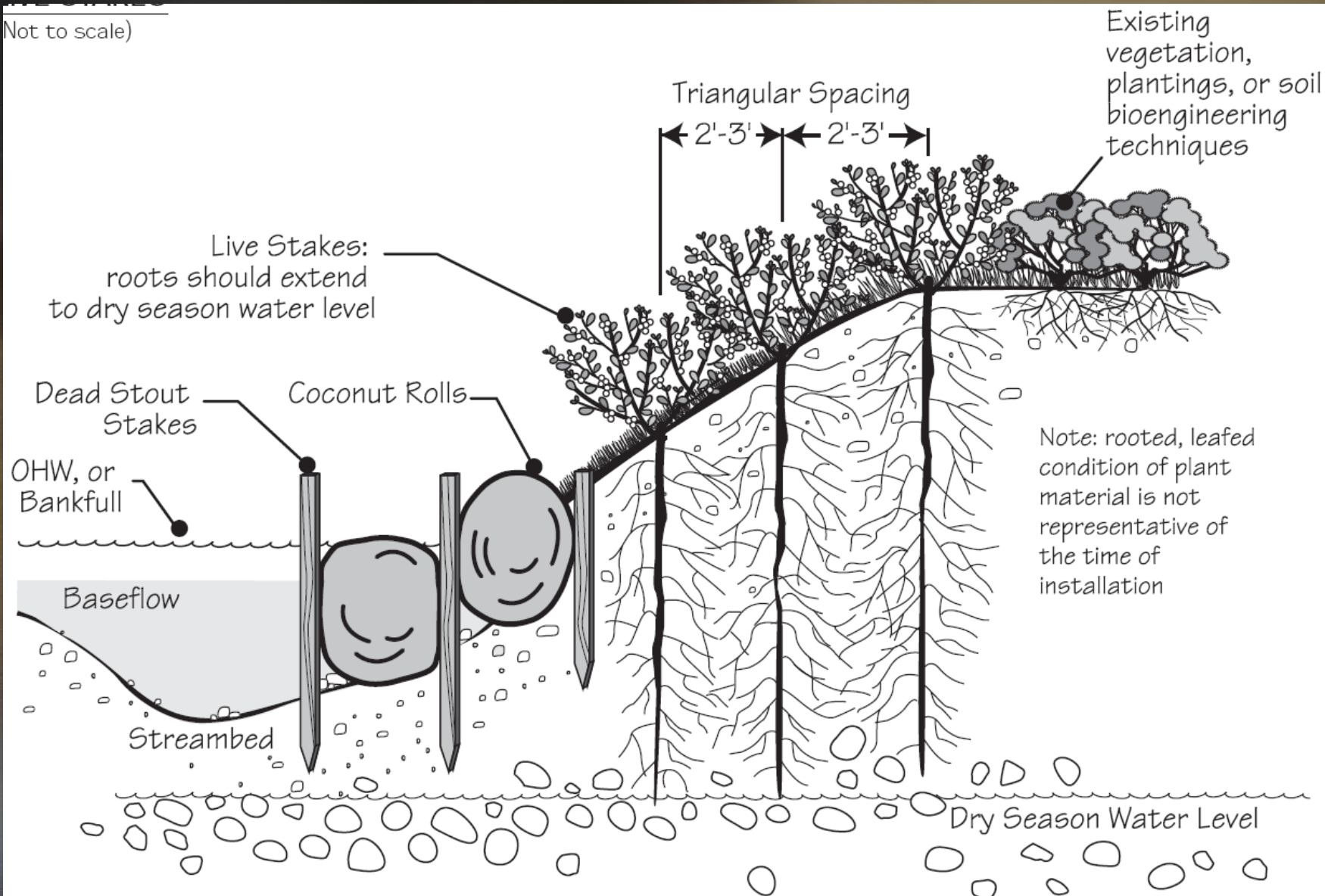








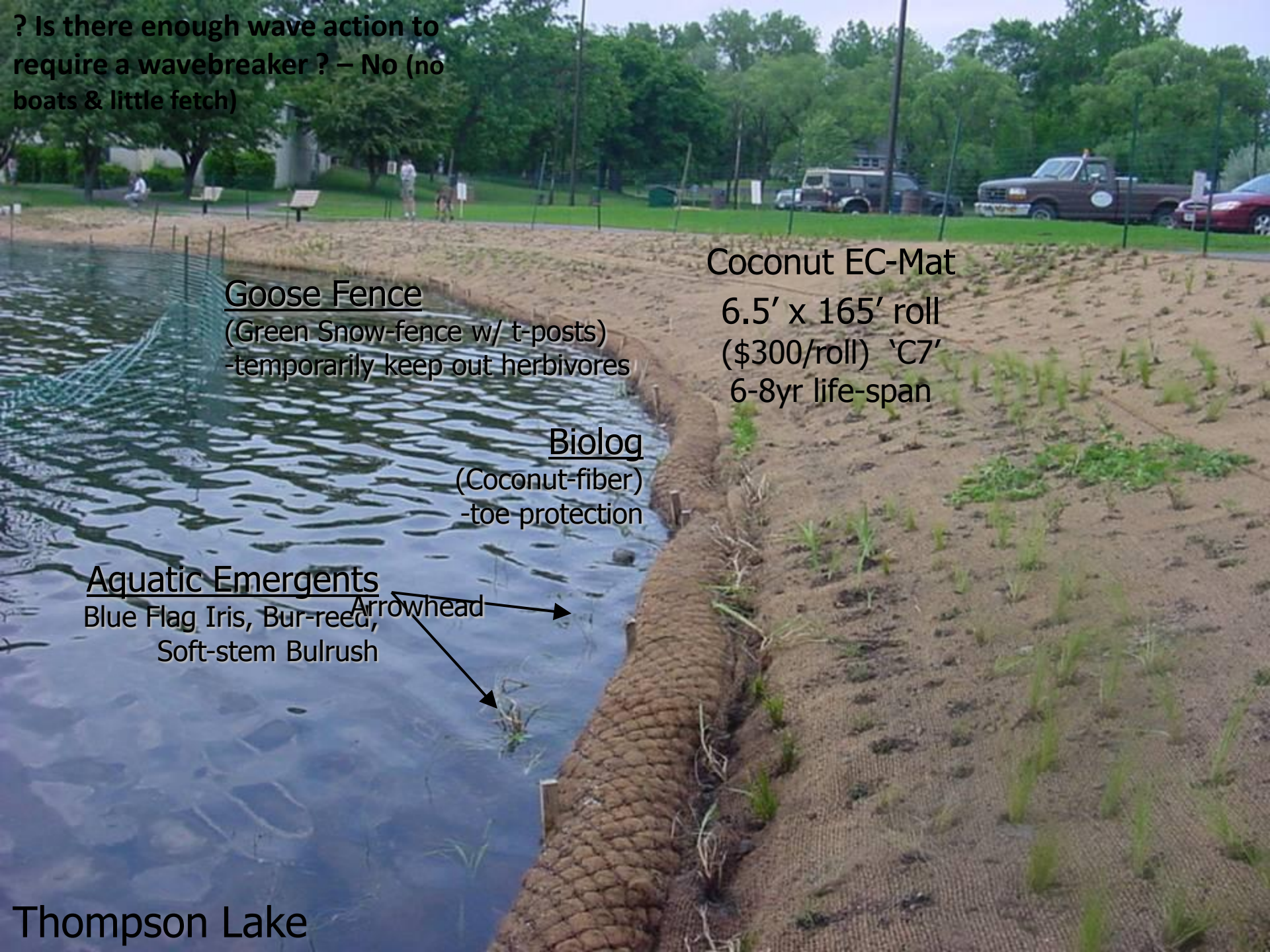
Not to scale)





Metro Conservation Districts  
Ramsey Conservation District





? Is there enough wave action to  
require a wavebreaker ? – No (no  
boats & little fetch)

### Goose Fence

(Green Snow-fence w/ t-posts)  
-temporarily keep out herbivores

### Coconut EC-Mat

6.5' x 165' roll  
(\$300/roll) 'C7'  
6-8yr life-span

### Biolog

(Coconut-fiber)  
-toe protection

### Aquatic Emergents

Blue Flag Iris, Bur-reed,  
Soft-stem Bulrush

Arrowhead

Thompson Lake





Metro Conservation Districts  
Ramsey Conservation District





Metro Conservation Districts  
Earth Wizards, Inc. project

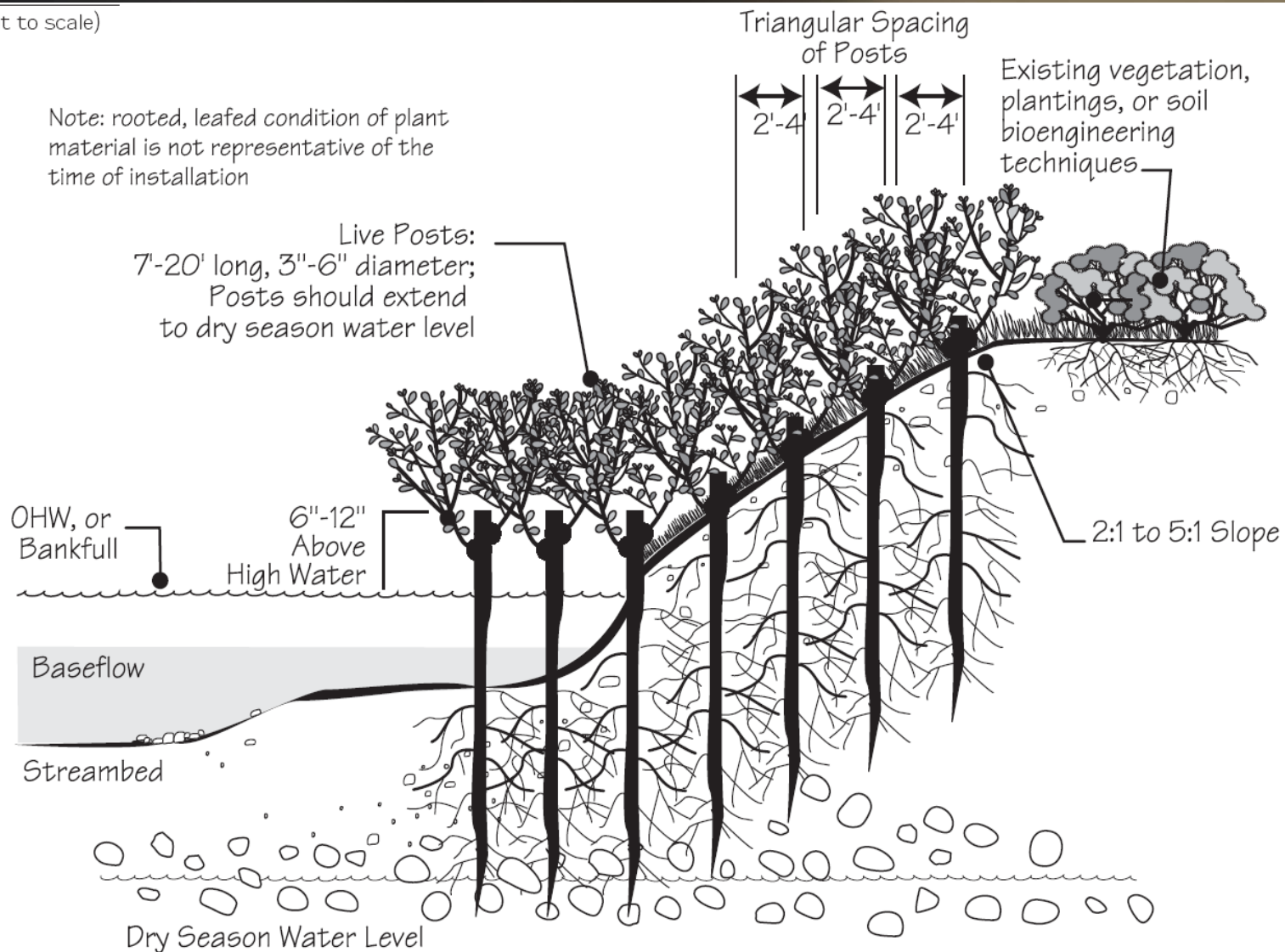




Metro Conservation Districts  
Earth Wizards, Inc. project

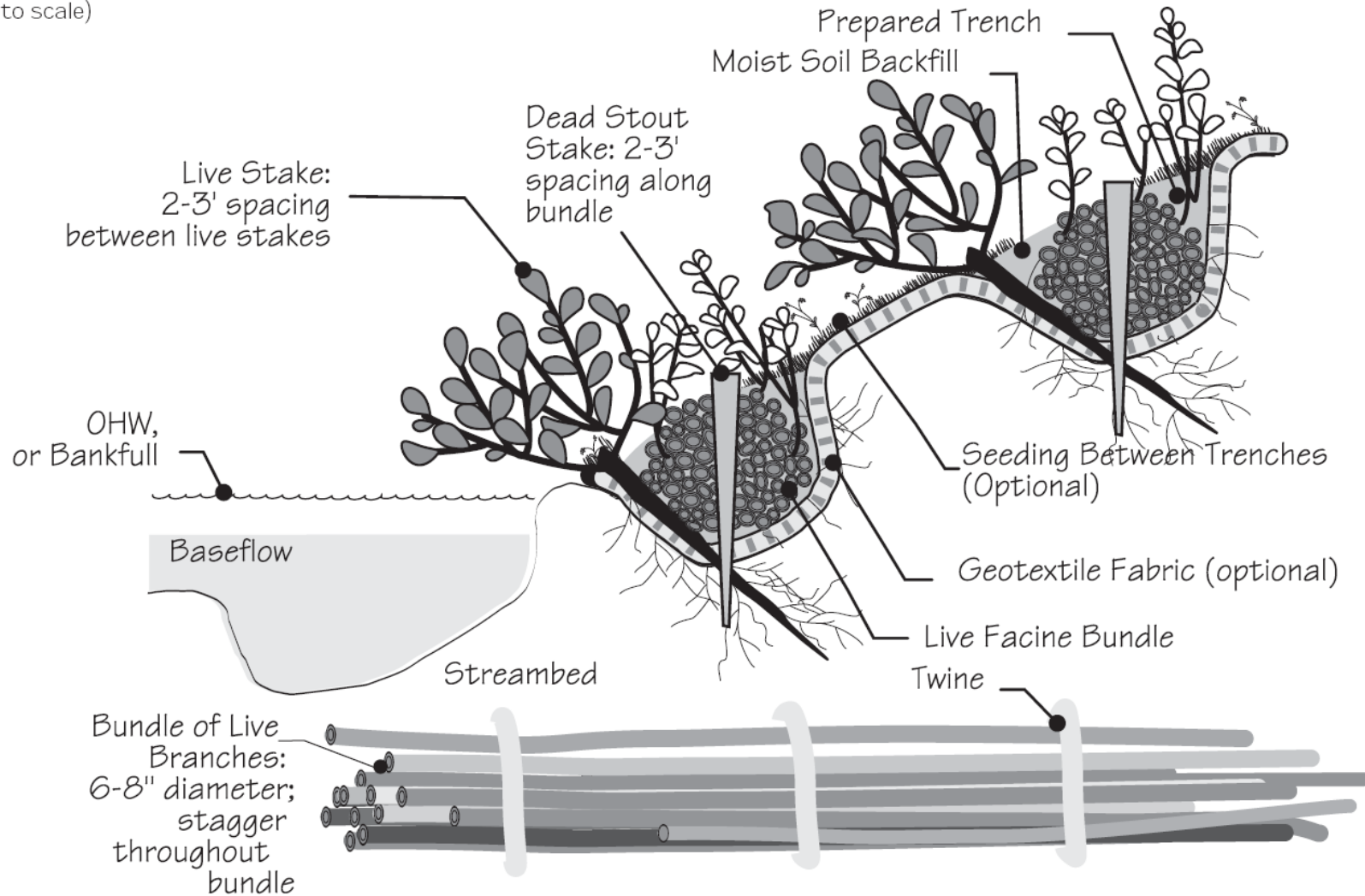


not to scale)

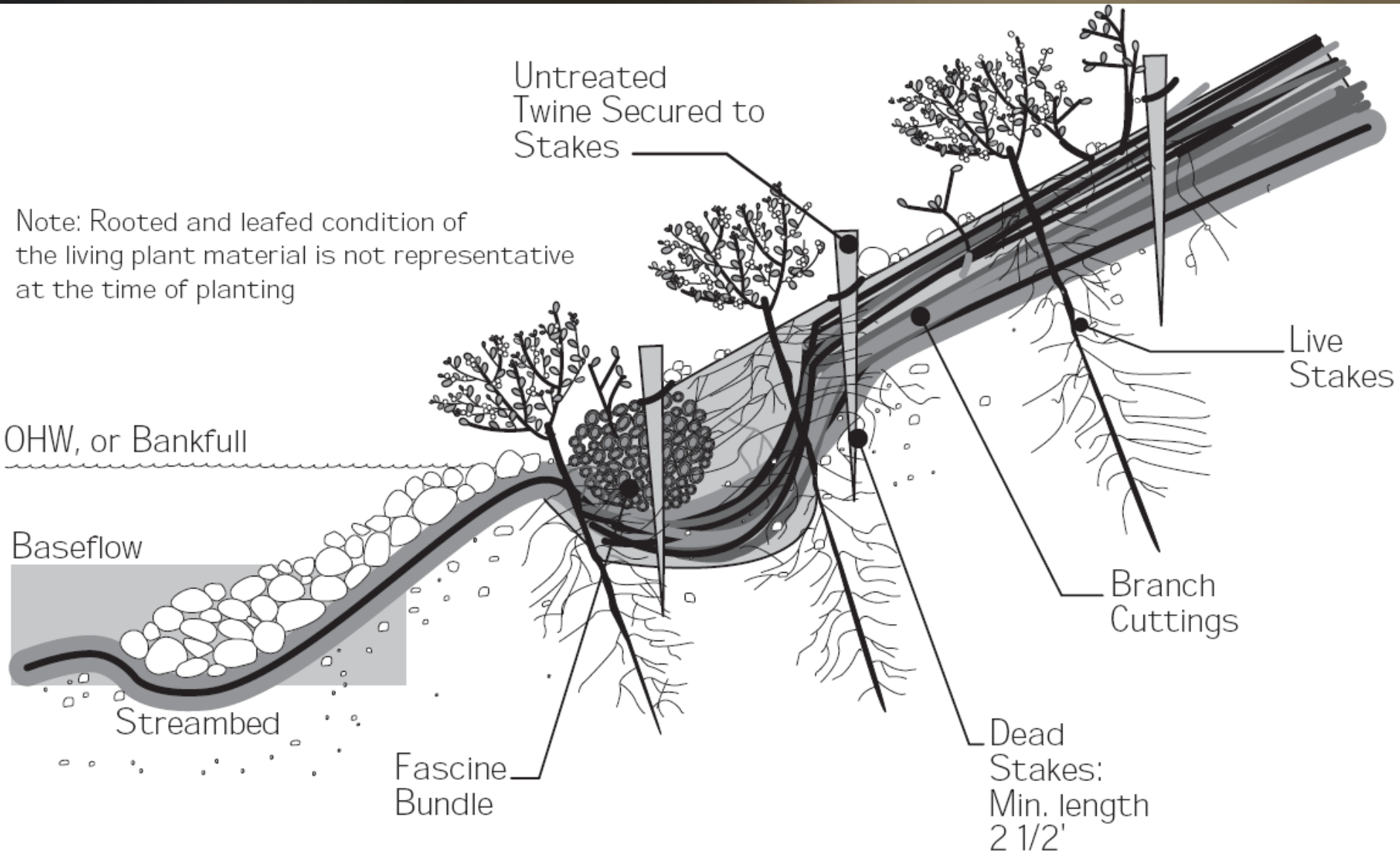




to scale)



Note: Rooted and leafed condition of the living plant material is not representative at the time of planting





Metro Conservation Districts  
Scott Conservation District





Metro Conservation Districts  
Anoka Conservation District



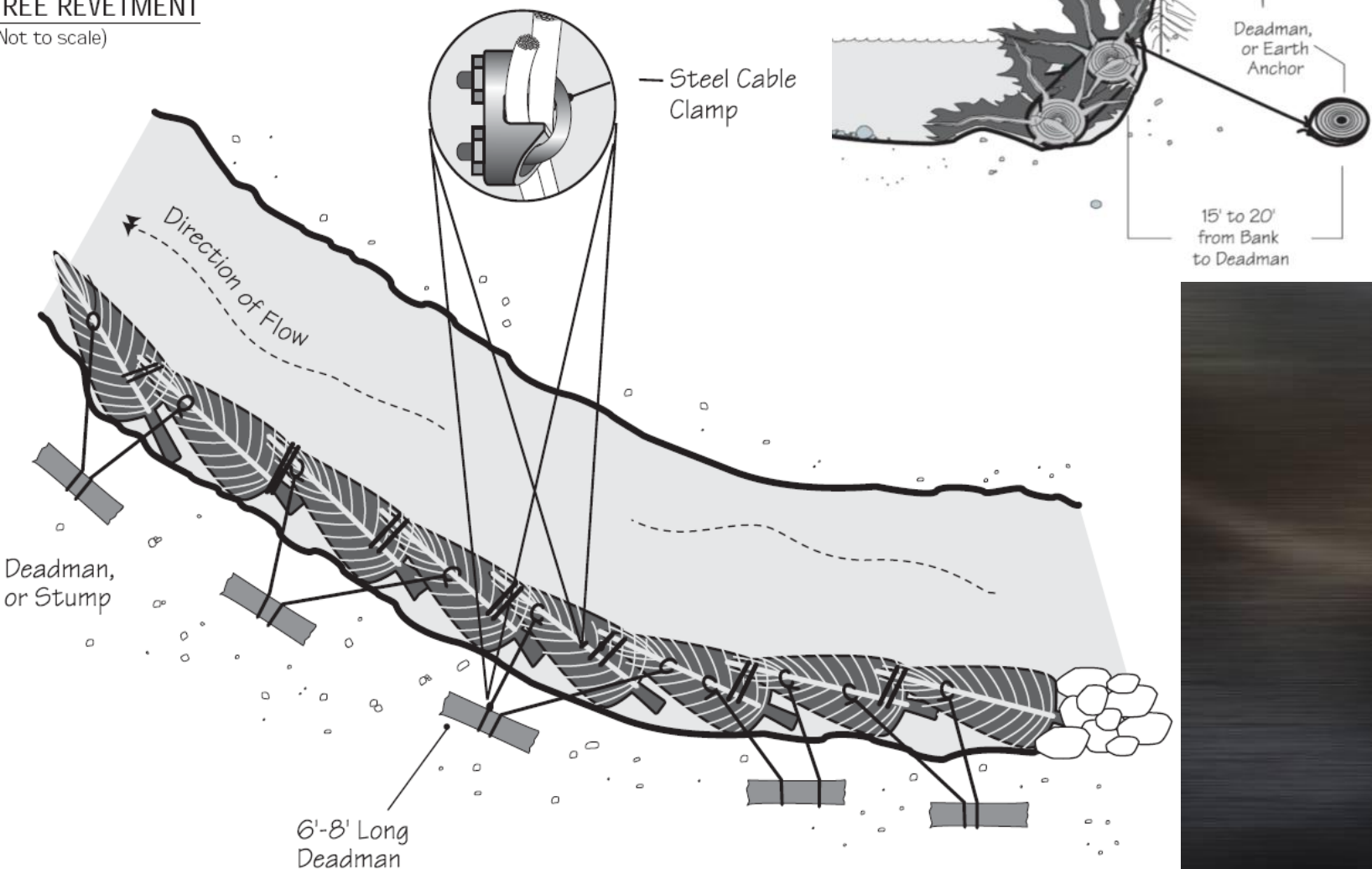


Metro Conservation Districts  
Anoka Conservation District



## REE REVETMENT

(Not to scale)



*A soil bioengineering guide for streambank and lakeshore stabilization,  
USDA Forest Service*





Metro Conservation Districts  
Anoka Conservation District





Metro Conservation Districts  
Washington Conservation District





Metro Conservation Districts  
Washington Conservation District





Metro Conservation Districts  
Anoka Conservation District



Straw wattle at crest —

*Carex pensylvanica* and *C. sprengei* planted  
at 12-inch spacing, *Diervilla lonicera* and *Aster*  
*macrophyllus* planted every 3-ft

CM7000/575-BN over new grade —

Cut material, from up-slope, integrated with leaf/grass  
compost and used as fill for new slope (max 1 to 1)

New bioloq (12-in, 7 lb) at new toe location —

New bare root plantings (24-in spacing) —

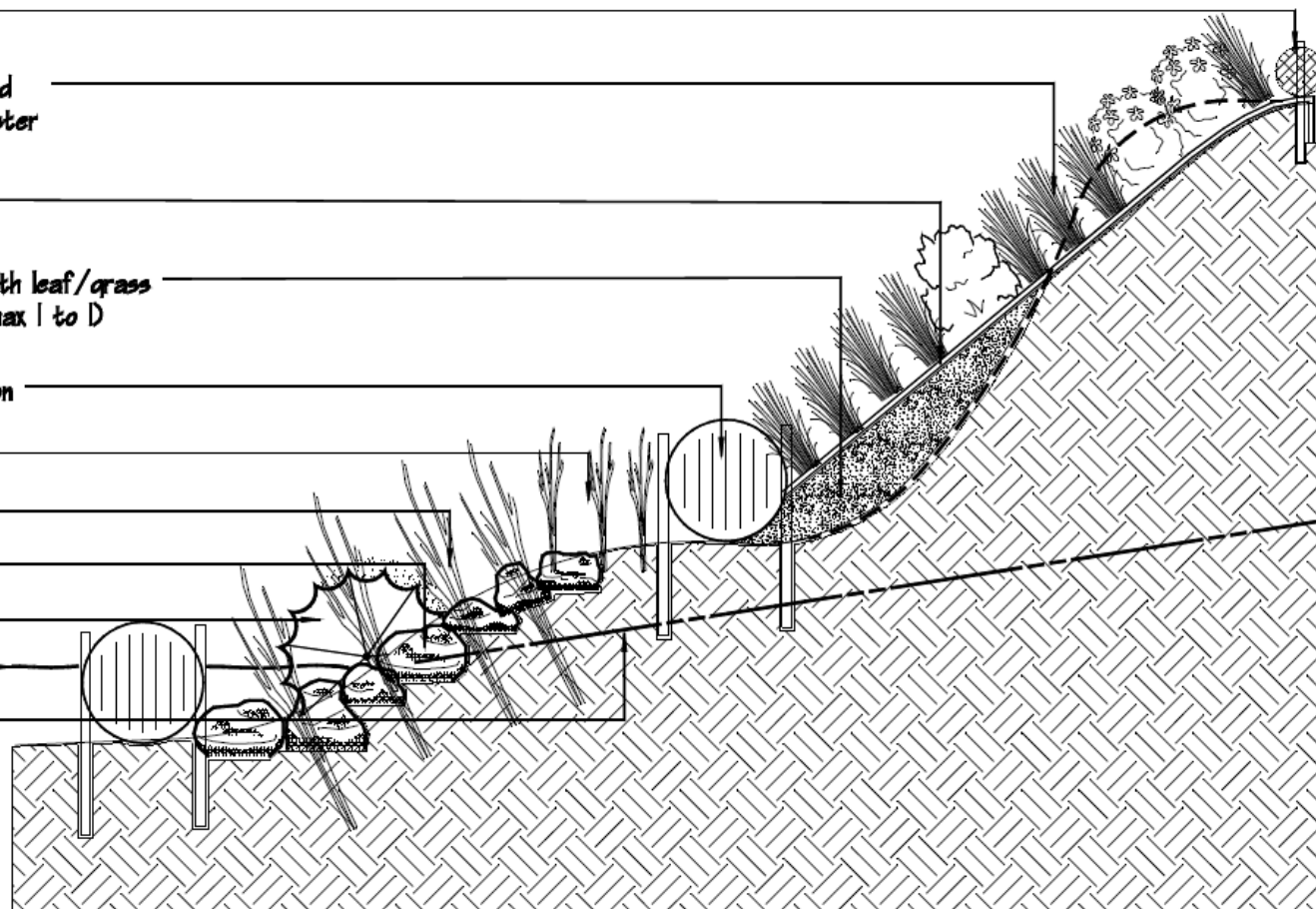
New live staking —

Existing rip-rap —

Existing cedar tree revetment —

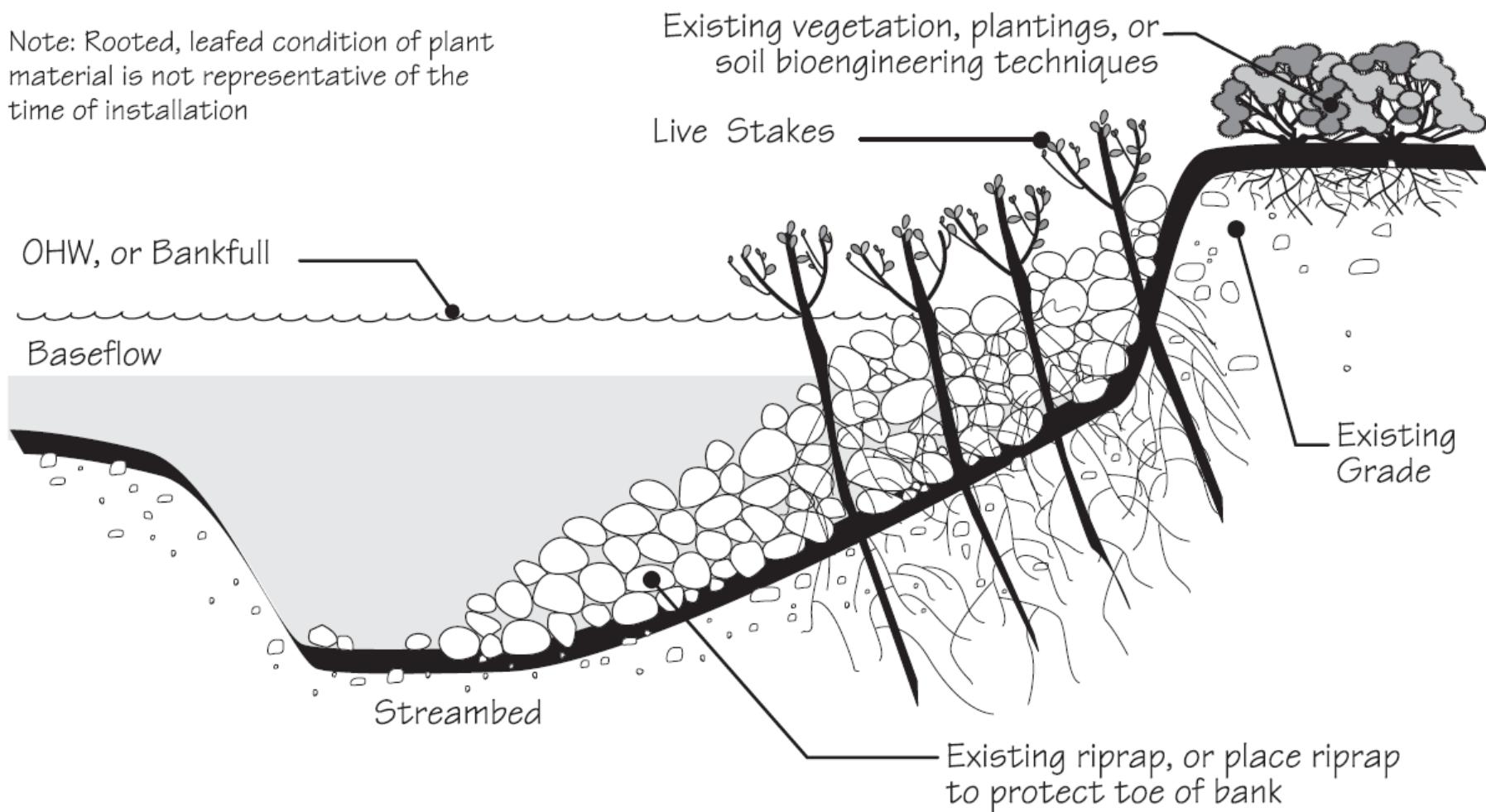
Normal water level —

Ground water —





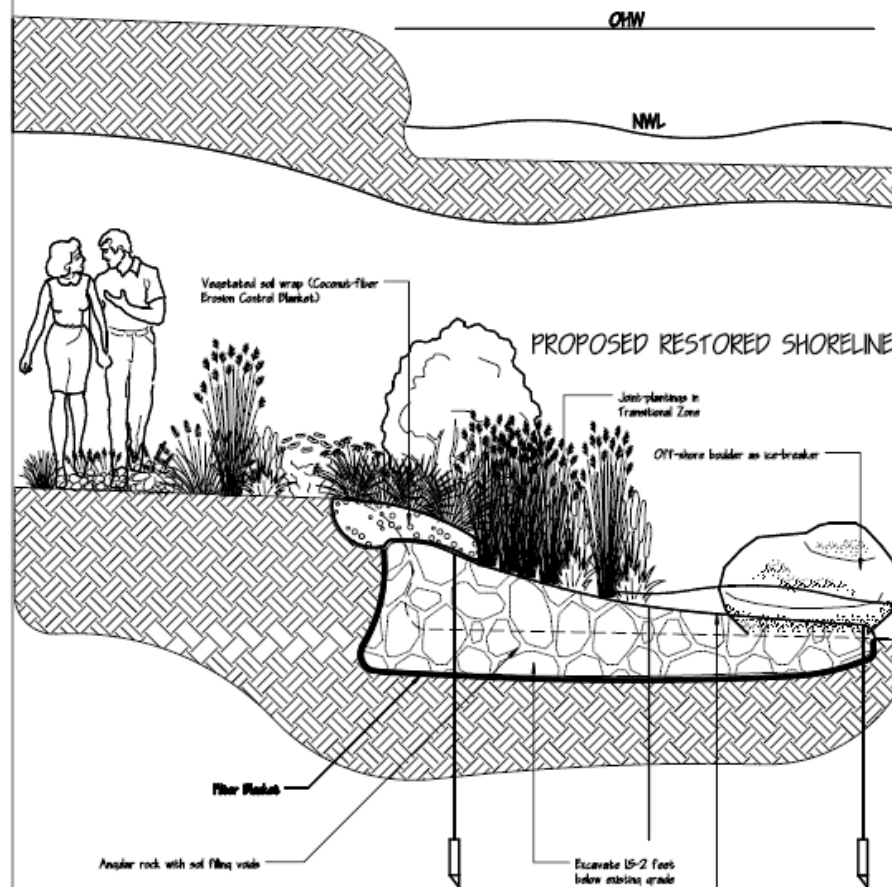
Note: Rooted, leafed condition of plant material is not representative of the time of installation







# APPROXIMATE EXISTING SHORELINE



## NOTES

1. Determination of rock size will consider a design windspeed of 51.55 ft/sec. See NRCS Engineering Field Handbook CH16, Appendix 16A.
2. If existing round stone is retained for use in the Vegetated Gabion Blanket, the minimum size that may be used should be 15 times the recommended diameter for angular rock. Use only in the base of the blanket, not within surface.
3. Wildlife exclusion fencing will surround the entire project (Upland and Transitional) for the entire first growing season and the first half of the second, at a minimum. Use a see-through, 4 ft green plastic fence and T-posts.
4. It is recommended that some form of wave-breaking structure be temporarily installed (for the first growing season) off-shore and lakeward from the boulders (e.g., branch boxes).

Surface of Gabion Blanket possibly contained with automated steel mesh or chain-link fencing. Mesh/Fencing anchored to soils with deckball anchors. 10:1 slope maximum.

## Cross-Sectional Concept Plan

Sheet 2 of 2

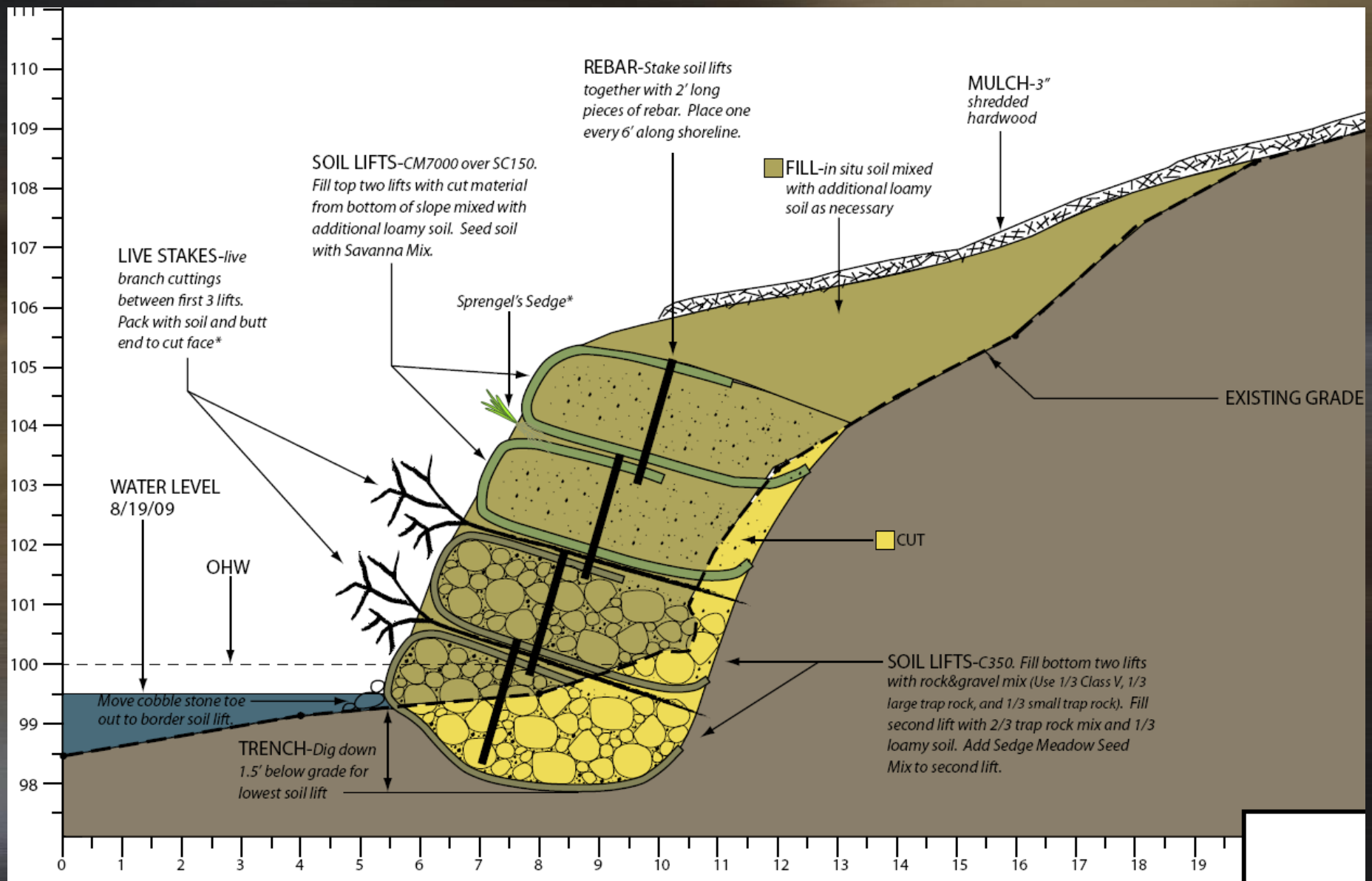
WASHINGTON COUNTY  
Lakeshore Stabilization

MAHLER RESIDENCE  
8899 North Shore Trail  
Forest Lake, MN

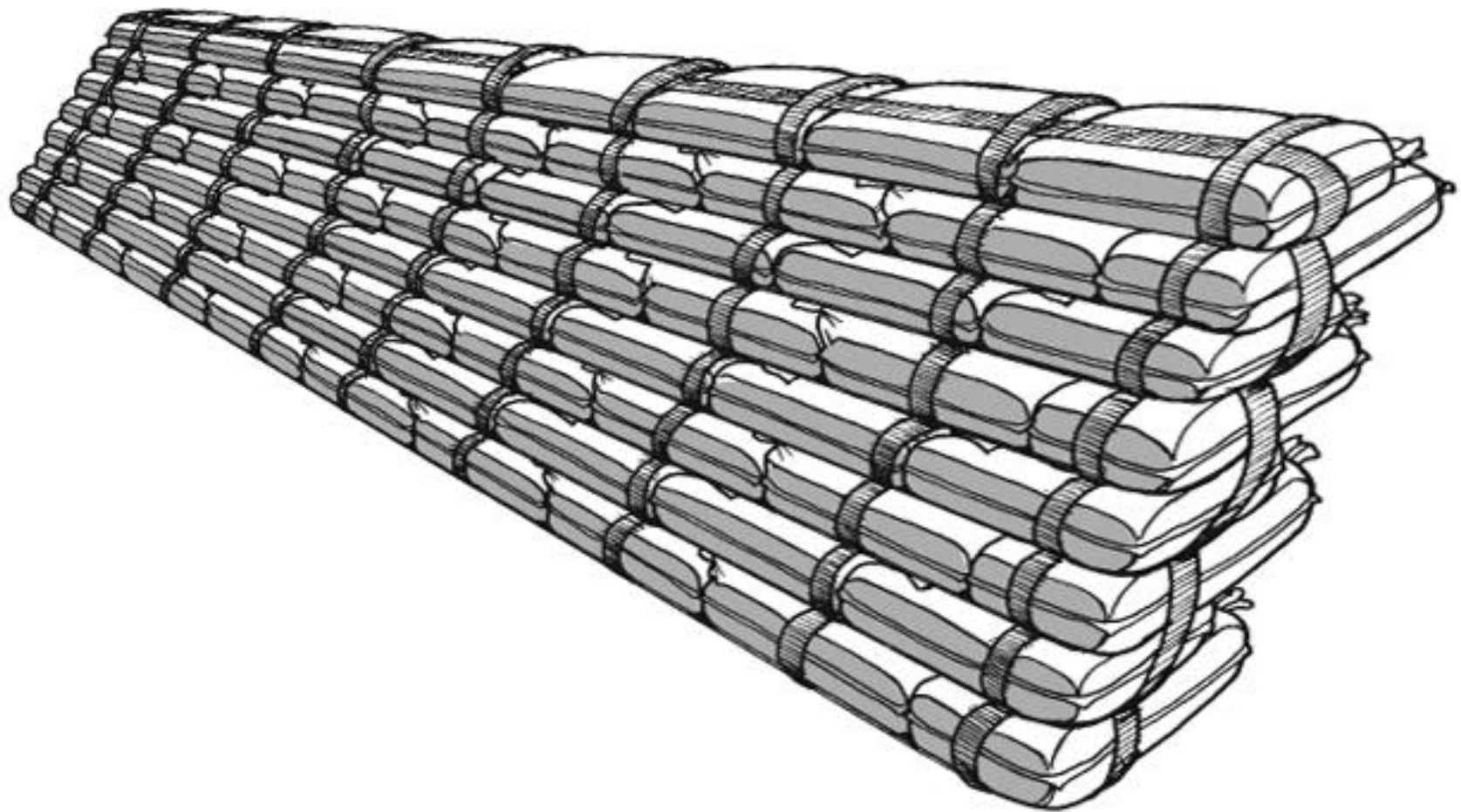
prepared by  
Washington Conservation District

in association with  
Association of Metropolitan Soil and Water Conservation Districts  
ANOKA - CARVER - HENNEPIN - RAMSEY - SCOTT - WASHINGTON

and the  
USDA - Natural Resources Conservation Service









©2007 Agrecol Corporation









©2007 Agrecol Corporation





Metro Conservation Districts  
Scott Conservation District





Metro Conservation Districts  
Scott Conservation District





Metro Conservation Districts  
Scott Conservation District





Metro Conservation Districts  
Scott Conservation District

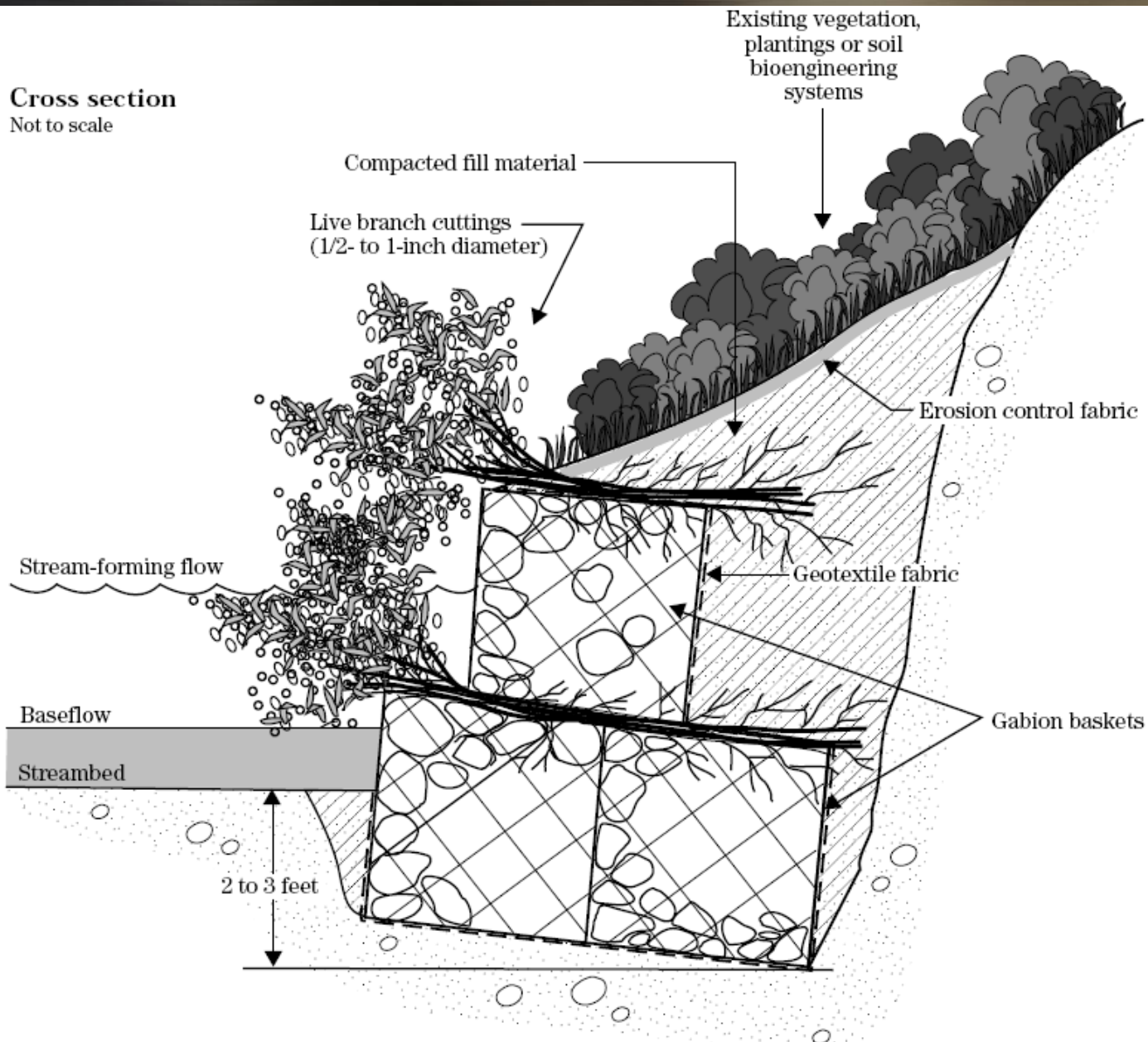




Metro Conservation Districts  
Scott Conservation District

## Cross section

Not to scale







(a)



*Stream corridor restoration: principals, processes, practices;*  
Federal interagency stream restoration working group



# Approaches: vegetated gabions





# Approaches: vegetated gabions

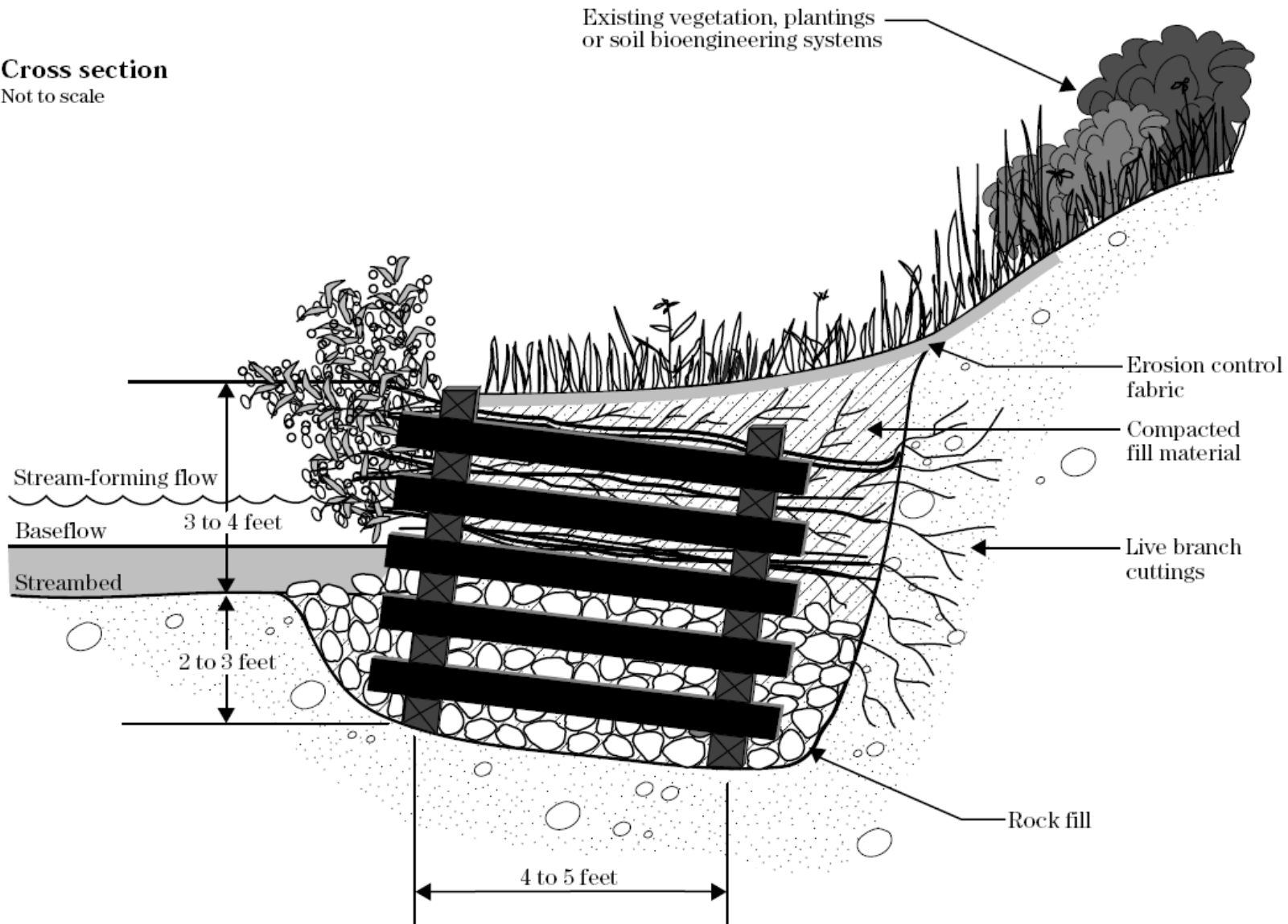




# Approaches: crib wall

## Cross section

Not to scale







## LAKE NOTES

Fetch Distance = 6200 ln ft

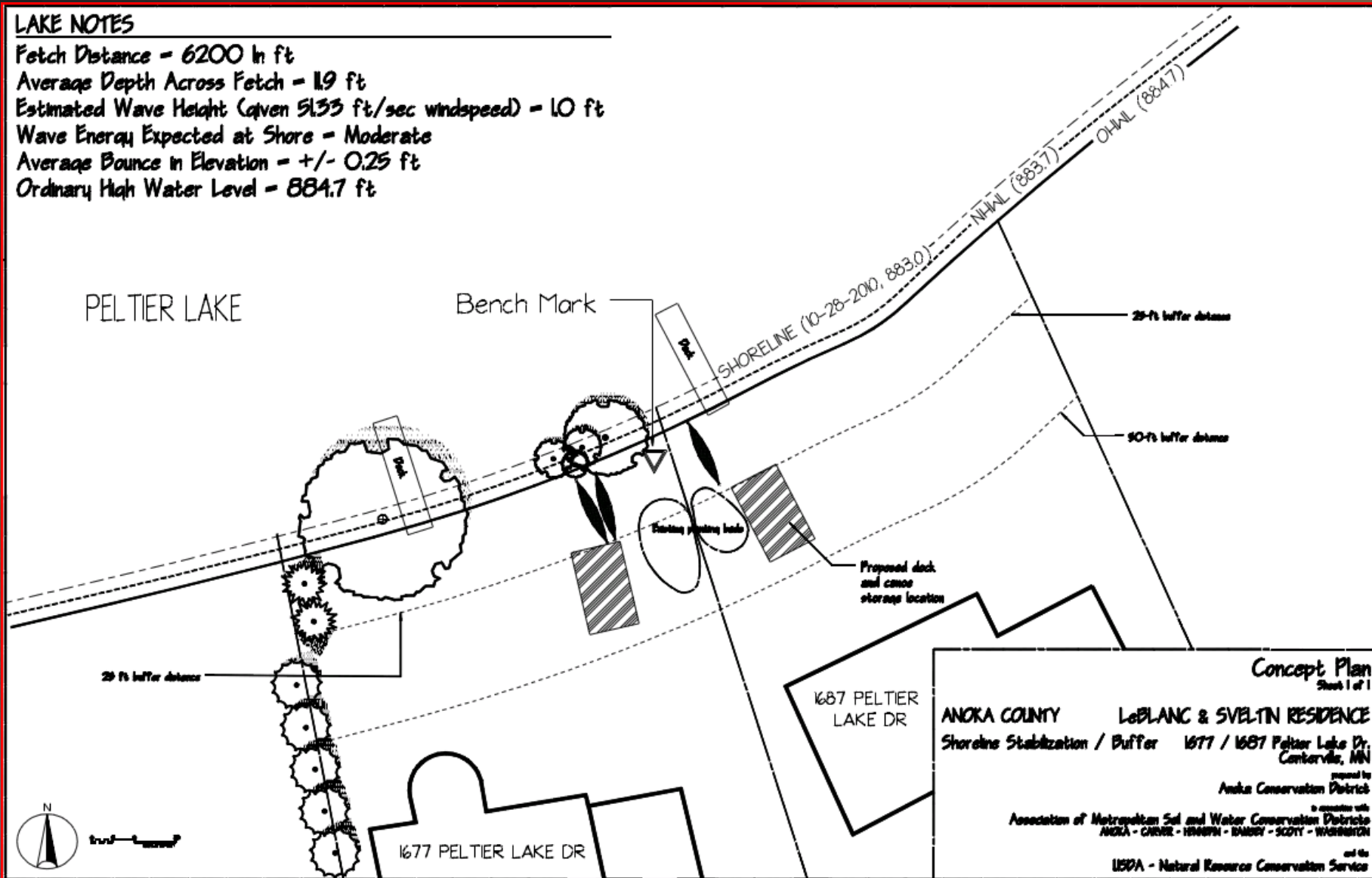
Average Depth Across Fetch = 11.9 ft

Estimated Wave Height (given 51.33 ft/sec windspeed) = 10 ft

Wave Energy Expected at Shore = Moderate

Average Bounce in Elevation = +/- 0.25 ft

Ordinary High Water Level = 884.7 ft





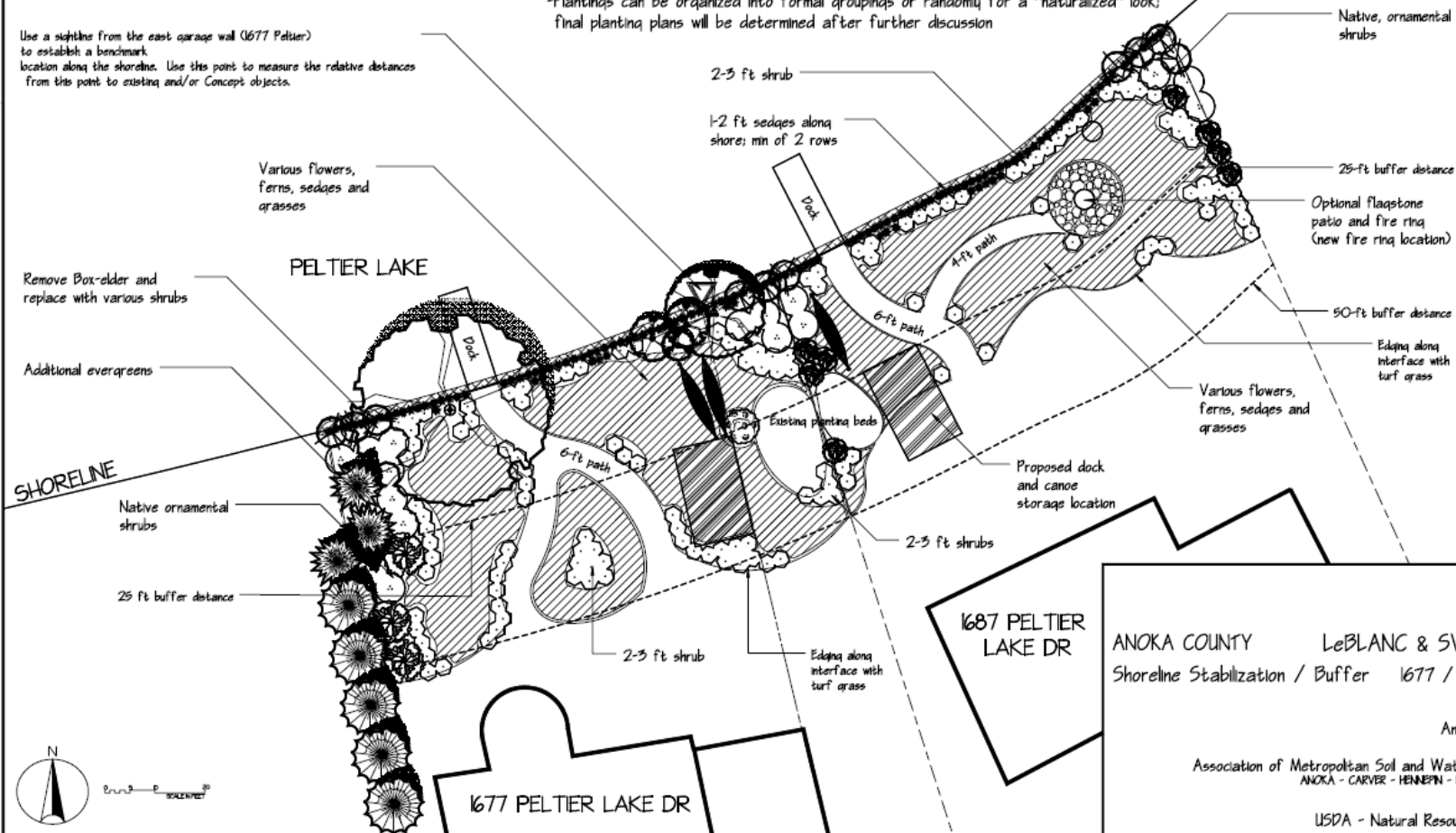
## LAKE NOTES

Fetch Distance = 6200 in ft  
 Average Depth Across Fetch = 19 ft  
 Estimated Wave Height (given 51.55 ft/sec windspeed) = 10 ft  
 Wave Energy Expected at Shore = Moderate  
 Average Bounce in Elevation = +/- 0.25 ft  
 Ordinary High Water Level = 884.7 ft

Use a sightline from the east garage wall (1677 Peltier) to establish a benchmark location along the shoreline. Use this point to measure the relative distances from this point to existing and/or Concept objects.

## PLANTING NOTES

- All plants used will be native to the site within a radius of 100 miles
- Only plants with dense, deep root structure will be used along the immediate shoreline (Transitional Zone)
- Care will be taken to preserve and frame in views of the lake and to add screening where desired
- Several forms of temporary, biodegradable erosion control products will be used to stabilize soils until plants are established
- It is highly recommended that some form of edging is used at the interface of the plantings and turf grass areas
- Plantings can be organized into formal groupings or randomly for a 'naturalized' look; final planting plans will be determined after further discussion



Concept Plan  
 Sheet 1 of 1

ANOKA COUNTY

LeBLANC & SVELTIN RESIDENCE

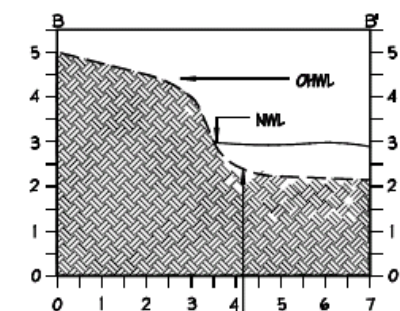
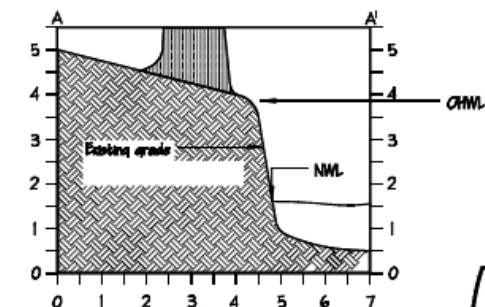
Shoreline Stabilization / Buffer

1677 / 1687 Peltier Lake Dr.  
 Centerville, MN

prepared by  
 Anoka Conservation District

In association with  
 Association of Metropolitan Soil and Water Conservation Districts  
 ANOKA - CARVER - HENNEPIN - RAMSEY - SCOTT - WASHINGTON

and the  
 USDA - Natural Resource Conservation Service



Existing grade

Existing Arborvitas (keep)

Dock Storage Area



Existing invasive shrubs (remove)

Existing Willow (keep)

Cross Section

LAKE

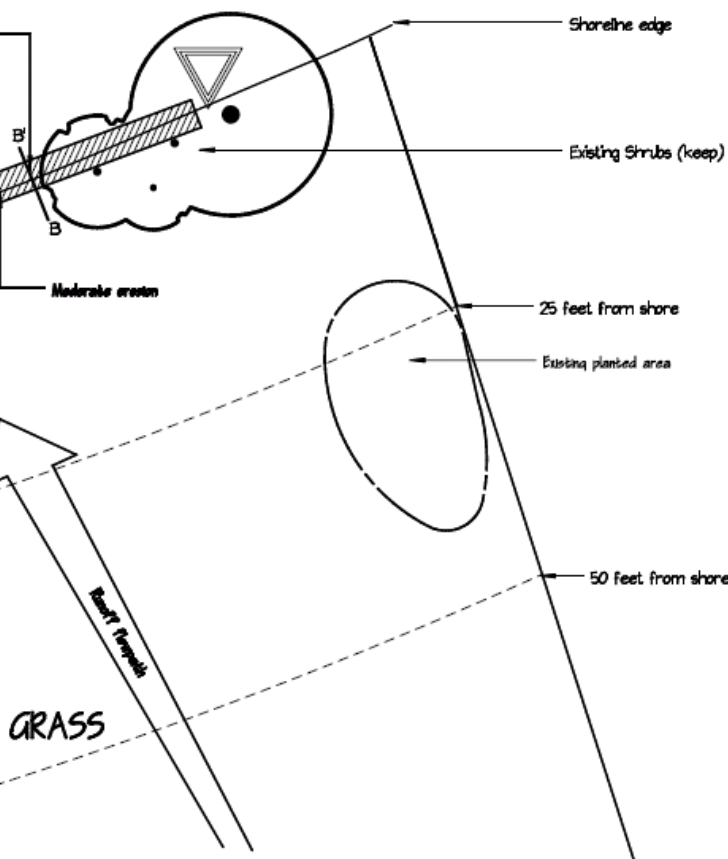
Major erosion

Barb. Pampas

SPARSE TURF GRASS

HOUSE

SCALE IN FEET



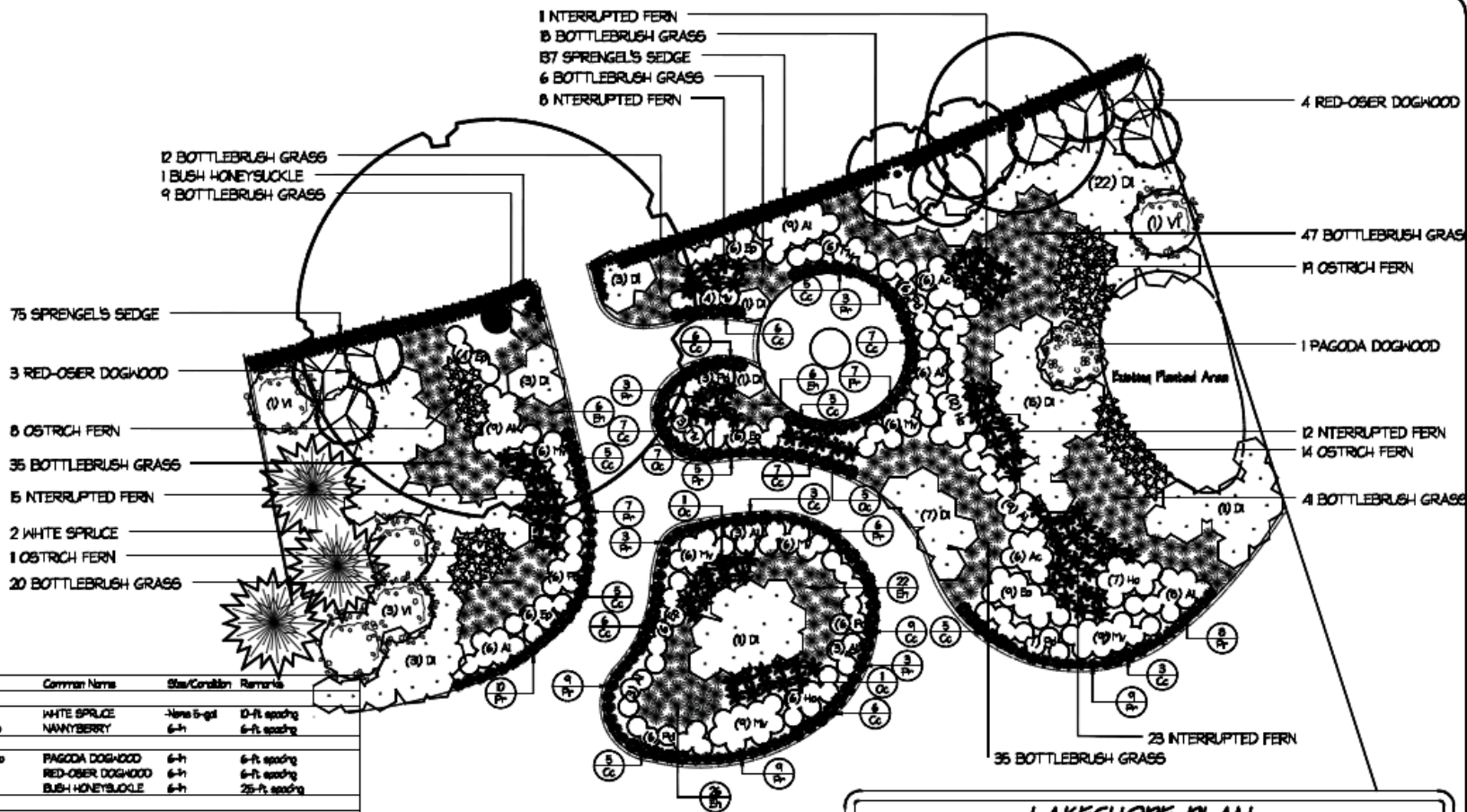
**LAKESHORE PLAN**  
**LeBLANC SHORELINE**  
 1677 Pettier Lake Dr, Centerville, MN

ANOKA COUNTY  
 Prepared by: Prepared by  
 Anoka Conservation District  
 in association with  
 Association of Metropolitan Soil and Water Conservation Districts  
 and the  
 USDA - Natural Resource Conservation District

Date	5-1-09
Sheet	1
Revision	
Scale	1-in = 10 ft







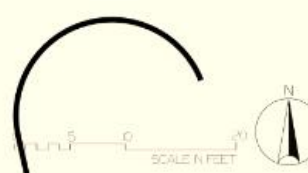
Key	Qty	Botanical Name	Common Name	Status/Condition	Remarks
<b>Trees</b>					
Pg	2	<i>Picea glauca</i>	WHITE SPRUCE	None 5-gal	10-ft spacing
Vi	5	<i>Viburnum lentago</i>	NANNYBERRY	6-in	6-ft spacing
<b>Shrubs</b>					
Cs	1	<i>Cornus alternifolia</i>	PAGODA DOGWOOD	6-in	6-ft spacing
Cs	7	<i>Cornus sericea</i>	RED-OSIER DOGWOOD	6-in	6-ft spacing
Di	15	<i>Diervilla lonicera</i>	BUSH HONEYSUCKLE	6-in	25-ft spacing
<b>Ornamental Grasses</b>					
Sh	255	<i>Styrax hibernica</i>	BOTTLEBRUSH GRASS	Flag	15-in spacing
<b>Perennials and Annuals</b>					
Ac	12	<i>Aquilegia canadensis</i>	WILD COLUMBINE	Flag	24-in spacing
Al	15	<i>Aster lateriflorus</i>	CALICO ASTER	Flag	24-in spacing
Cs	22	<i>Cornus sericea</i>	SPRENGEL'S SEDGE	Flag	12-in spacing
Cs	40	<i>Cornus canadensis</i>	BUNCH BERRY	45-in	15-in spacing
Sp	37	<i>Sporobolus purpureus</i>	PURPLE JOE PYLE NEED	Flag	24-in spacing
Ha	25	<i>Hieracium autumnale</i>	SNEEZEWEED	Flag	24-in spacing
Os	52	<i>Ostrya virginiana</i>	OSTRICH FERN	6-in	24-in spacing
Vi	55	<i>Viola virginiana</i>	VIOLIN BLUEBELLS	45-in	15-in spacing
Os	125	<i>Osmunda cinnamomea</i>	INTERRUPTED FERN	6-in	24-in spacing
Pi	34	<i>Potamogeton amplifolius</i>	WOODLAND PALM	45-in	15-in spacing
R	82	<i>Rumex crispus</i>	JAGGED LADDER	Flag	15-in spacing

# LAKESHORE PLAN LEBLANC SHORELINE 1677 Pettier Lake Dr, Centerville, MN

ANOKA COUNTY  
Prepared by: Prepared by  
Anoka Conservation District  
in association with  
Association of Metropolitan Soil and Water Conservation Districts  
and the  
USDA - Natural Resources Conservation District

Date 5-1-09  
Sheet 2  
Revision  
Scale 1 in = 10 ft

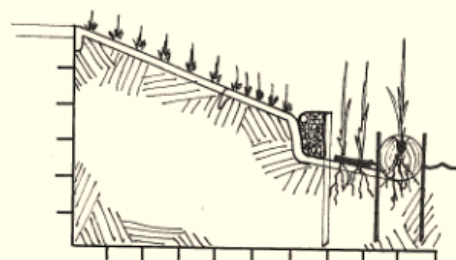
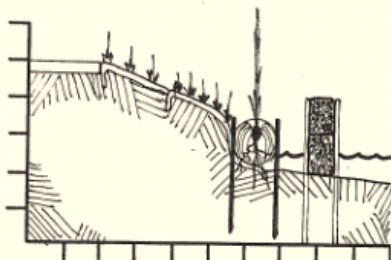
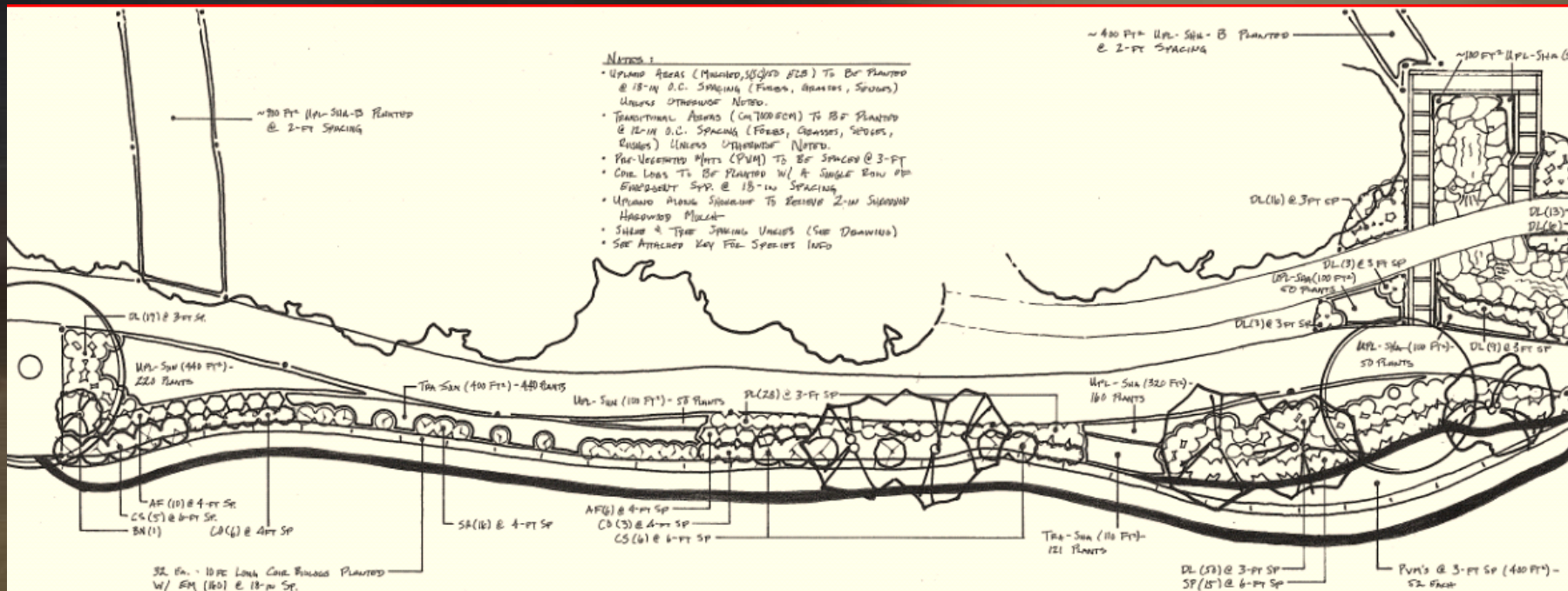




<p style="text-align: center;"> <b>LAKE SHORE PLAN</b>  <b>LeBLANC SHORELINE</b>  <b>1677 Peltier Lake Dr, Centerville, MN</b> </p>	
<p> <b>ANOKA COUNTY</b>          Prepared by: Prepared by          Anoka Conservation District          in association with          Association of Metropolitan Soil and Water Conservation Districts          and the          USDA - Natural Resource Conservation District       </p>	<p>         Date: 5-1-09          Sheet: 2          Revision:          Scale: 1 in = 10 ft       </p>

# Notes:

- Upland Areas (Mounded, 30" H<sub>2</sub>O) To Be Planted @ 18" IN O.C. SPACING (FORNS, GRASSES, SEDGES, UNLESS OTHERWISE NOTED)
- Transitional Areas (CULTUREM) To Be Planted @ 18" IN O.C. SPACING (FORNS, GRASSES, SEDGES, UNLESS OTHERWISE NOTED)
- Pre-Vegetated Mtns (PVM) To Be Spaced @ 3-FT
- Core Logs To Be Planted W/ A SINGLE ROW P/V
- Fire-Safe Sp. @ 18" IN SPACING
- Upland Along Shoreline To Receive 2" IN SLOTTED HARDWOOD PILES
- Shrub & Tree Spacing UNLESS (SEE DRAWINGS)
- SEE ATTACHED KEY FOR SPECIES INFO



- EXISTING PILE WALL INTO CHANNEL, NOT AT SHORELINE

- ANCHOR PVM W/ SOME STRUCT STREETS

## Shoreline Planting Plan

Sheet 4 of 4

Ramsey County

Prince of Peace

Raingardens and Woodland Restoration

2561 Victoria Ave.

Roseville, MN

prepared by:  
Ramsey Conservation District

in association with:  
the Association of Metropolitan Soil and Water Conservation Districts

Anoka • Carver • Dakota • Hennepin • Ramsey • Scott • Washington

and the  
USDA - Natural Resources Conservation Service



Scale:











November 2004



# INSTALLATION

- General tips
- Emergent zone
- Transitional zone
- Upland zone
- Wave breaks
- Exclusion fencing
- Oversight and contracting

# MAINTENANCE

- Establishment period = installation
- Determining establishment period
- Watering
- Weed control
- Inspection
- Contracting